

9 HYDROGEOLOGY AND GROUND CONDITIONS

9.1 INTRODUCTION

9.1.1 This chapter assesses the potential effects of the development proposals on the underlying soils and groundwater. The assessment is primarily concerned with soils and hydrogeology within the application site, though consideration of off-site effects is also considered, as necessary. The assessment addresses the conditions which are likely to be currently present (Baseline), and assesses the potential effects that could occur during preparation and construction on site (Construction Phase) and once the site is redeveloped (Operational Phase) and will outline mitigation measures to control the predicted effects of the proposals.

9.1.2 The assessment considers the following aspects:

- Anticipated character of soils and the potential presence of contamination from past site uses.
- Anticipated type and character of geological features.
- Preliminary assessment of risk associated with development on a potentially contaminated site.

9.2 ASSESSMENT APPROACH

9.2.1 Details on ground conditions associated with the proposed development site are taken from the Phase 1 Detailed Desktop Study undertaken by Rolton Group Ltd in May 2016 (see **Appendix 9.1**).

9.2.2 The Phase 1 Detailed Desktop Study has included a Conceptual Site Model (CSM) providing a depiction of likely sources of contamination, pathways and receptors, resulting in the identification of potential pollutant linkages.

9.2.3 The following data sources have been consulted as part of this assessment:

- British Geological Survey mapping and website
- A Walkover Inspection of the site
- An Envirocheck Report provided by the Landmark Group
- Historical Ordnance Survey mapping of the site and surrounding area
- Environment Agency website

9.2.4 No intrusive site investigations have been undertaken or made available for review at this stage. This assessment assumes that our review of the information sources outlined above provides a reasonable indication of the potential for ground contamination beneath the site. However, it is possible that ground contamination may exist beneath the site arising from land uses or events not revealed on mapping or emanating from adjacent land.

9.2.5 This assessment uses the guidance given in the National Planning Policy Framework (NPPF). The NPPF replaced (amongst other documents) Planning Policy Statement (PPS) 23: Planning and Pollution Control, and other Planning Policy Statements and Planning Policy Guidance. Of specific relevance to this assessment, the NPPF states:

- To prevent unacceptable risks from pollution and land instability, planning policies and decisions [by Planning Authorities] should ensure that new development is

appropriate for its location. The effects (including cumulative effects) of pollution, on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

9.2.6 Planning decisions should also ensure that:

- The site is suitable for its use taking account of ground conditions and land instability, including natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation.
- After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990.
- Adequate site investigation information, prepared by a competent person, is presented.

9.2.7 The assessment methodology is based on the following criteria;

- Consideration of the type of effect, only if deemed significant; i.e. the effect will present a risk of a significant degree to a particular receptor/resource being evaluated.
- The probability of the effect occurring.
- The severity of the effect on a particular receptor/resource being evaluated.
- The magnitude of risk being evaluated as Major, Moderate, Minor, Negligible, or Neutral.

9.2.8 The significance of the effects have been considered with a matrix-based approach such that the effects are derived from the receptor's environmental sensitivity value in combination with the magnitude of the effect at that receptor. The matrix criteria are set out below.

Table 9.1: Significance Matrix

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

Table 9.2: gives generic criteria for determining levels of magnitude of change on the physical environment.

Table 9.2: Level of Significance Criteria

Significance Criteria	Description of criteria
Major beneficial	Substantial reduction in risk to human and ecological health. Major improvement in onsite and offsite soil and water quality.
Moderate beneficial	Moderate reduction in risk to human and ecological health. Moderate improvement in onsite soil and water quality. Minor improvement to offsite soil and water quality.
Minor beneficial	Minor reduction in risk to human and ecological health. Minor improvement to onsite soil or water quality.
Neutral/Not Significant	No change to soil or water quality, or harm caused to any identified receptors.
Minor adverse	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.
Moderate adverse	Chronic damage to human health. Pollution of sensitive water resources. A significant change in a particular ecosystem or organism forming part of such ecosystem.
Major Adverse	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem or organism forming part of such ecosystem.

9.2.9 Risk assessment is the process of collating known information on a hazard or set of hazards in order to estimate actual or potential risk to receptors. The receptor may be human, a water resource, a sensitive local ecosystem or construction materials. Receptors can be linked to the hazardous source by one or several exposure pathways such as direct contact for example. Risks are generally managed by isolating the receptor or intercepting the exposure pathway or by isolating or removing the hazard.

9.2.10 Without the three essential components of a source, pathway and receptor, there can be no risk. Therefore the presence of a hazard on a site does not necessarily mean there is a risk.

9.2.11 In the risk assessment the consequence of the hazard has been classified as severe or medium or mild or minor and the probability (likelihood) of the circumstances actually occurring classified as a high likelihood or likely or low likelihood or unlikely.

9.2.12 For the purposes of the EIA, the assessment of likely significant effects and likely residual effects will be based on significance criteria derived in line with good practice. The criteria consider controlled waters, human health, ecological and property receptors listed in the contaminated land statutory guidance and Environment Agency Model Procedures for the Management of Contaminated Land (CLR11).

9.3 BASELINE CONDITIONS

9.3.1 A review of available historical maps for the site has been undertaken as part of the preliminary desk studies.

9.3.2 The site and immediately surrounding land was farmland (with farm buildings in the north of the site) until development in the 1930s and 1940s with Power Stations in the vicinity and electrical transformers on site. There is the possibility of gravel workings in the south of the site before 1888.

9.3.3 Industrial features in the immediate site vicinity have included: railway lines, Power Stations, Electricity transmission equipment, Industrial Distribution buildings and Vehicle Storage.

9.3.4 The site was cleared between 2006 and 2016 and is being used for Vehicle Storage (cars and vans).

9.3.5 The site is indicated as being originally underlain by Second Terrace River Deposits (sand and gravel) overlying the Mercia Mudstone Group.

9.3.6 Indicative soil geochemistry mapping by the BGS estimates low concentrations of Arsenic, Lead, Cadmium, Nickel and Chromium on site.

9.3.7 The Envirocheck Report indicates that there is a 'very low' risk to 'no hazard' from the following ground stability hazards on and around the site: running sands, ground dissolution, compressible ground, collapsible ground, landslides and swelling clay.

9.3.8 The Envirocheck Report confirms that the site is in a lower probability Radon area. Lower probability areas have less than 1% of homes above the Radon action level. The British Geological Survey (BGS) and National Geoscience Information Service assessment suggests that Radon protection measures are not required in new dwellings or extensions.

9.3.9 Aquifer Designation mapping by the Environment Agency indicates that the site is underlain by a 'Secondary A' aquifer, corresponding with the site's superficial drift

geology, and by a 'Secondary B' aquifer within the solid geology. The site is not within a Source Protection Zone (SPZ).

9.3.10 **Secondary A aquifers** – 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.'

Secondary B aquifers – '*predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.*'

9.3.11 There are no groundwater or surface water abstractions recorded on the site. The nearest groundwater abstraction is recorded at 745m north east of the site with water used for agricultural purposes.

9.3.12 The nearest surface water feature is recorded 121m north west of the site and appears to be a small pond. The River Tame is approximately 700m to the north east and south east of the site at its closest points.

9.3.13 The site is not recorded as being at risk from flooding from rivers without defences.

9.3.14 There are no Pollution incidents, Discharge Consents, Local Authority Pollution Prevention and Control Permits arising from the site.

9.3.15 The site is not situated on a recorded operational or historic landfill site. The nearest landfill site is an historic facility located 430m to the south – a former gravel works since filled with Power Station wastes.

9.3.16 The site has initially been indicated to have a medium probability of encountering unexploded ordnance (UXO). In accordance with *CIRIA C681 Unexploded Ordnance, a Guide for the Construction Industry on managing UXO risks*, it is recommended that a Detailed UXO Assessment is undertaken prior to undertaking intrusive investigations or development of the site.

9.3.17 Potential sources of site-based contamination are principally associated with historic land uses on the site and surrounding area:

- Farm buildings were present in the north of the site and possible gravel working took place in the south of the site prior to 1888.
- Development of the site with electrical transformers took place before 1959.
- Surrounding land was developed with Power Stations including railway lines in the 1930s and 1940s.
- Further Power Stations were developed post-WWII. Clearance of the power Stations and associated railway lines took place in the 1980s and 1990s and surrounding land was used for Industrial Distribution buildings and Vehicle Storage to the present.
- The nature and type of contamination resulting from past uses of the site and immediately surrounding land may include, amongst others: ash and fill, hydrocarbons (e.g. fuel oils), heavy metals and asbestos.
- Historic shallow gravel extraction may have taken place on site or in the immediate vicinity.

9.3.18 Potential pathways include the following:

- Ingestion of soils or dust;
- Inhalation of dust;
- Inhalation of vapour or soil gas;
- Dermal contact with soils;
- Dermal contact with perched groundwater;
- Vertical and lateral migration of dissolved phase contamination (leaching);
- Lateral migration of dissolved phase contamination in water flow;
- Transport of non-aqueous phase contaminants (hydrocarbons);
- Uptake of soil pore water by plants; and
- Upward vertical migration of ground gas into buildings.

9.3.19 Potential human health, controlled water and ecological receptors include:

- Site workers and neighbours (Construction Phase);
- Future site workers/residents/employees within the new facility (Operational Phase);
- Future maintenance workers (Operational Phase);
- The Secondary A and Secondary B Aquifers within the superficial deposits and bedrock, underlying the site;
- The nearest surface water features are small ponds. The River Tame is in the vicinity (700m from site).
- Below-ground construction materials.

9.4 ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

Construction Phase

9.4.1 A plausible pollutant linkage has been identified in the conceptual model relating to construction workers and neighbours in the short term during the excavation and re-use of potentially made ground during the development of the application site.

9.4.2 Consequently it is recommended that specific precautions are taken to reduce potential exposure in accordance with the principle of 'as low as reasonably practical' (ALARP). This should include appropriate briefings, protective equipment (PPE), sanitary provision and dust suppression as to be detailed within the Construction Environment Management Plan (CEMP) for the proposed development. Further details are set out in the mitigation section below.

9.4.3 Without mitigation procedures and accounting for the possibility of contaminants within made ground on site related to the historical land use, during the development,

the risk of harm to construction workers during the construction phase is assessed to have a Moderate Adverse Effect.

9.4.4 Without mitigation procedures, the risk of harm to neighbours (primarily from dust emissions) is assessed to be a Minor Adverse Effect.

9.4.5 The site is underlain by Secondary A and Secondary B aquifers within the superficial deposits and bedrock underlying the site. A potential pollutant linkage exists between contaminants within the soils and perched waters on site and the underlying aquifers. The consequence of onsite pollution of the groundwater therefore must be considered given the geology beneath the site and the sensitivity of the underlying aquifer.

9.4.6 There are surface water features in proximity to site including small ponds and the River Tame. A potential pollutant linkage exists between contaminative material within the shallow soils and made ground material across the site and surface water features in proximity to the site.

9.4.7 Without mitigation procedures during development the risk of harm to controlled waters during the construction phase of the development is assessed to have a Moderate Adverse Effect.

9.4.8 A potential linkage exists for Unexploded Ordnance to injure workers and neighbours and destroy buildings. Without mitigation procedures and accounting for the possibility of UXO material in site soils, the risk of harm to human health during the construction phase of the development is assessed to have a Major Adverse Effect.

Operational Phase

9.4.9 Post development of the site during the Operational Phase, a large proportion of the site will be covered with hardstanding, roads or building slabs, which will break most of the plausible linkages to future site workers and users (such as ingestion and dermal contact) in these areas. However a plausible pollutant linkage to future site users will remain in any areas of soft landscaping.

9.4.10 A potential pollutant linkage exists between contaminants in the made ground and shallow soils and maintenance workers, the risks to maintenance workers can be reduced by implementing specific precautions to reduce potential exposure in accordance with the principle of 'as low as reasonably practical' (ALARP). Further details are set out in the mitigation section below.

9.4.11 A potential pollutant linkage exists between ground gas generating soils and future site users, if gas can flow or permeate through building envelopes and accumulate within enclosed spaces in the proposed new development buildings. Ground gas monitoring and assessment should be undertaken. The risks to future site users from ground gas can be mitigated assuming the building foundations provide suitable mitigation for the Characterisation Situation classified for the site as listed in *C665B Assessing Risks Posed by Ground Gases to Buildings* and *BS 8485 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*.

9.4.12 A potential pollutant linkage exists between users and contaminants in the ground via water supply pipes (and the water within). The local water supply company should be consulted regarding the pipe material and back fill specification of potable water supply pipes.

9.4.13 Without mitigation procedures and accounting for the possibility of contaminated material in made ground on site, the risk of harm to human health during the operational phase of the development is assessed to have a Moderate Adverse Effect.

9.4.14 A potential pollutant linkage has been identified between contaminants present in the perched water on site and the Secondary A and Secondary B aquifers within the superficial deposits and bedrock.

9.4.15 A potential pollutant linkage has been identified between potential contaminants present in perched water within granular deposits across the site and within surface water features in proximity to the site.

9.4.16 Without mitigation procedures during the development the risk of harm to controlled waters during the operational phase of the development is assessed to have a Moderate Adverse Effect.

9.4.17 Without mitigation procedures the effect to ecological receptors (new landscaping) during the operational phase of the development is assessed to have a Minor Adverse Effect.

9.4.18 A potential linkage exists between potentially aggressive contaminants in the made ground and natural soils and below ground concrete used within the new development. The concrete used within the development should be designed in accordance with the concrete classification for the site (assessed using BRE Special Digest 1).

9.4.19 Without mitigation procedures the effect to building materials during the operational phase of the development is assessed to have a Moderate Adverse Effect.

9.4.20 The temporary storage of waste and any licensed or unlicensed discharge from the site may result in the production of potentially mobile contaminants that may unintentionally gain access to ground, which may result in Moderate Adverse Effects on controlled waters and the surrounding environment.

9.4.21 The operation of the site may create dust or airborne contaminants, resulting in Minor Adverse Effects on human health and the environment.

9.5 MITIGATION AND ENHANCEMENT

9.5.1 There is the potential that materials within the made ground may pose a risk to construction workers (direct contact/ingestion and inhalation) and neighbours (from dust emissions) in the short term during the excavation and re-use of made ground materials. During the redevelopment of the site it will be necessary to implement measures to protect construction workers from exposure to any contaminated material which is encountered.

9.5.2 To provide a qualitative assessment of potential contamination, it is recommended that a geo-environmental ground investigation be undertaken prior to development to provide an assessment of the ground conditions on the application site with respect to geotechnical properties and any potential contamination in the underlying soils and or groundwater.

9.5.3 Appropriate measures to protect construction workers may include training in and enforcement of hygiene procedures, use of personnel protective equipment and the implementation of dust control measures. Mitigation measures that will be used to counter the identified potential effects of construction will be incorporated into the

Contractors Method Statements and Health and Safety Plans and the CEMP. These will include:

- Procedures and protocols to prevent construction workers, visitors and neighbours from being exposed to contaminated materials.
- Monitoring of excavation works to identify unforeseen areas of contamination and hazardous gases.
- Systems to record and monitor the movement and deposition of waste materials leaving or being transported to other parts of the site.
- Preventing dust generation during excavation and handling of potentially contaminated materials.

9.5.4 If visual or olfactory evidence of contamination is observed during the construction phase the material should be segregated and tested. A suitably qualified person should be responsible for inspecting and testing any material which displays any visual and/or olfactory signs of contamination. Based on the results of testing, the soils will be re-used, treated or disposed of off-site as required. Proposed criteria for the re-use of soils will be included in the earthworks specification for the development.

9.5.5 When the mitigation procedures outlined above are implemented during the development the risk of harm to construction workers and neighbours during construction is Neutral.

9.5.6 A potential pollutant linkage exists between site end users, maintenance workers, new planting and potentially contaminated soils in areas of new landscaping. To mitigate against this linkage it is envisaged during the Operational Phase, a large proportion of the site will be covered with hardstanding, roads or building slabs. A clean and inert capping layer underlain with a coloured demarcation geotextile material should be placed over in-situ soils in areas of public access soft landscaping. These cover soils should be validated prior to placement.

9.5.7 When the mitigation procedures outlined above are implemented, the risk of harm to end users, maintenance workers and visitors is Neutral.

9.5.8 Proposed criteria for the re-use of soils and testing frequencies will be included in the earthworks specification for the development. When the mitigation measures outlined are implemented the risk of harm to human health during the operational phase of the development is assessed to be Neutral.

9.5.9 To mitigate against risks from ground gases, building slabs and membranes will be designed to mitigate the Characteristic Situation classification for the site, if found to be required. Ground gas monitoring will be undertaken to classify the gas regime, as described within BS 8485 and C665. When the mitigation measures are implemented the risk of harm to human health during the operational phase of the development is assessed to be Neutral.

9.5.10 A potential pollutant linkage has been identified between contaminants present in soils and perched water within granular deposits across the site and the underlying Secondary A and Secondary B aquifers and surface water features in proximity to the site boundary. The sensitivity of the water resources is moderate and the probability of occurrence during operation is considered to be minor due to a large proportion of the site will be covered with hardstanding, roads or building slabs.

9.5.11 To mitigate against risks from contaminants in perched water:

- Sampling and testing will be required of groundwater to identify contamination presence.
- Collection and disposal of potentially contaminated groundwater will be subject to appropriate Environment Agency guidance and permits.
- Run-off or discharge of groundwater from the site will be prevented.
- The collection of rainfall or surface run-off in potentially contaminated soils shall be avoided as far as reasonably practicable by management of excavations, and intervention of surface water and appropriate disposal.

9.5.12 When the mitigation procedures outlined above are implemented during the development the risk of harm to controlled waters during construction is Neutral.

9.5.13 The concrete used within the development should be designed in accordance with the concrete classification for the site (assessed using BRE Special Digest 1). When the mitigation measures outlined above are implemented the risk during the operational phase of the development is assessed to be Neutral.

9.5.14 The preliminary UXO reports recommends undertaking a detailed UXO Report. Following any recommendations in the Detailed UXO report during the construction phase of the development, risks to construction workers would be assessed to be Neutral.

9.5.15 Any chemical or fuel stored on site during the operation of the plant would require bunded containers to prevent contamination of the ground and controlled waters. The proposed development would be regulated under an Environmental Permit and would be subject to regular inspection and record keeping. As a result, no significant effects on geology, soils and contamination are predicted during the operation of the plant, which would be subject to its own operational methodology and risk assessments and no specific mitigation measures are proposed as part of this assessment.

9.6 CUMULATIVE AND IN-COMBINATION EFFECTS

9.6.1 There are no foreseen significant cumulative and in-combination effects during construction or once the facility is operational.

9.7 SUMMARY

Introduction

9.7.1 A qualitative assessment of the effects of the proposed development arising from likely ground conditions has been completed. The assessment has considered the extent and methods of foundation construction, the anticipated degree of disturbance of the ground, the final form of the development, and the relevant national policies for contaminated land assessment and management.

Baseline Conditions

9.7.2 The baseline ground conditions at the site have been assessed by a Phase 1 Desktop Study.

Likely Significant Effects

9.7.3 Prior to mitigation, a number of likely significant effects have been identified relating to the risk of the effects of contaminated land on construction workers, end users and controlled waters.

Mitigation and Enhancement

9.7.4 The following mitigation measures have been recommended:

- Undertake a Detailed Unexploded Ordnance Threat and Risk Assessment prior to carrying out intrusive site investigation works (and development).
- Undertake a Phase 2 Geo-environmental Ground Investigation prior to development to provide an assessment of the ground conditions on the application site with respect to geotechnical properties and any potential contamination (including hazardous gases) in the underlying soils and/or groundwater.
- Application of appropriate measures during the construction phase to protect construction workers, site neighbours and the environment more generally, from exposure to any contaminated material which may be encountered (e.g. dust control measures, containment of soil and groundwater arising from works in the ground, use of appropriate PPE).
- If piling through the Secondary A aquifer is required as part of the development, a Report on Piling and Risks to Groundwater should be completed to the satisfaction of the Environment Agency (EA). The piling technique should be chosen to mitigate risks to controlled waters.
- The safe stockpiling, containment and testing of material displaying visual or olfactory evidence of contamination during the construction works. Based on the results of subsequent testing, the stockpiled soils should be re-used, treated or disposed of off-site.
- A 'clean' and inert soil cover layer should be placed over in-situ soils in areas of new landscaping. The cover soils should be validated prior to placement.
- Building slabs and membranes should be designed to mitigate the Characteristic Gas Situation classification for the site; ground gas monitoring should be undertaken to classify the gas regime, as described within BS 8485 and C665.
- The concrete used within the proposed development should be designed in accordance with the concrete classification for the site (assessed using BRE Special Digest 1).
- The local water supply company should be consulted regarding the pipe material and backfill specification of potable water supply pipes.
- Operation on sealed hard standing would ensure any oils/lubricants or wastes are not able to penetrate into the underlying natural ground and controlled waters.
- Develop systems in line with the plant/facility Environmental Permit to ensure all potential contamination issues associated with the operation of the facility would have been satisfactorily controlled.

Conclusion

9.7.4 Following the implementation of the recommended mitigation measures the residual effect of the proposed development with respect to all receptors is assessed to be Neutral, as either ground contamination sources or transport pathways to receptors will have been removed.