

10. Geology, Ground Conditions and Contamination

Introduction

- 10.1 This chapter assesses the likely significant effects of the proposed development on the site off Cherryfield Drive. In particular, it considers the potential effects of the historic site uses and the associated potentially contaminated land.
- 10.2 The chapter describes the methods used to assess the likely significant effects, the baseline conditions currently existing at the site and in its surroundings, the potential direct and indirect effects of the proposed development arising from the construction and the operational phase, the mitigation measures required to prevent, reduce, or offset the identified significant effects and the residual effects. It has been written by E3P Ltd.
- 10.3 This Chapter is supported by the following documents which are provided in Appendix 10.1 and 10.2:
- E3P Ltd Phase I and II Geoenvironmental Site Assessment Cherryfield Drive, Kirkby, Liverpool, L32 8RX. Report Reference 15-280-R1-1. Dated April 2022.
 - E3P Ltd Remediation and Enabling Works Strategy Cherryfield Drive, Kirkby. Report Reference 15-280-R2-2. Dated April 2022.

Planning Policy Context

National Planning Policy

National Planning Policy Framework

- 10.4 The National Planning Policy Framework (NPPF) indicates that principal planning objective when considering development on land affected by contamination is to ensure that any unacceptable risks to human health, buildings and other property, and the natural and historical environment from the contaminated condition of land are identified, so that appropriate action can be considered and then taken to address those risks.

- 10.5 To prevent unacceptable risks from pollution and land instability, planning policies and decisions 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 rest with the developer and/or landowner.
- 10.6 The NPPF planning policies and decisions should also ensure that:
- The site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that 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.

Local Planning Policy

- 10.7 The Knowsley Replacement Unitary Development Plan (UDP) was adopted in 2006. Under the transitional arrangements for moving to the Local Plan system the council 'saved' all but four of the 82 individual UDP policies, the 'saved' policies will remain in place until, in most cases, they are replaced by new policies in the Local Plan.
- 10.8 A key objective of the UDP is Objective 9 which is summarised below:

Objective 9

To make efficient use of previously developed land and buildings in providing land for new development. An important role of the UDP is to ensure that the use of greenfield land for new development is minimised. This will be achieved by focussing new development primarily towards previously developed (brownfield) land and buildings in the urban area. The sites identified in the UDP for new development (e.g. for new housing, industry or town centre uses such as shopping) are therefore mainly on brownfield sites.

Other Relevant Policy, Standards and Guidance

10.9 The assessment completed by E3P has been guided by the following legislation and good practice with due regard to the NPPF:

- Part 2A Environmental Protection Act 1990
- Environment Agency Land Contamination: Risk Management (LC:RM) 19 April 2021
- Environment Agency Groundwater Protection: Policy and Practice (GP3) 2008
- BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land)

10.10 Part 2A of the Environmental Protection Act (EPA) 1990, introduced by s57 of the Environment Act 1995 (Reference 13.2), came into force in England on 1 April 2000. The main objective of introducing the Part 2A regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land.

10.11 The main documents that set out procedures for the conduct of technical processes or activities which may be relevant or partially relevant to Part 2A includes The Environment Agency LC:RM guidance and this document recommends a phased or tiered approach to risk assessment including:

Stage 1: Risk assessment

- Preliminary risk assessment.
- Generic quantitative risk assessment.
- Detailed quantitative risk assessment.

Stage 1 includes information for intrusive site investigations.

Stage 2: Options appraisal

- Identify feasible remediation options.
- Do a detailed evaluation of options.
- Select the final remediation option.

Stage 3: Remediation and verification

- Develop a remediation strategy.
- Remediate.
- Produce a verification report.
- Do long term monitoring and maintenance, if required.

10.12 The assessment that is reported within the E3P Phase I and II Geoenvironmental Site Assessment (Appendix 10.1) encompasses a review of the available historical and geoenvironmental information and the collection of field data and laboratory testing and the completion of generic quantitative risk. As potential risks were identified, E3P has also completed the specification of remediation options, which are summarised within the Remediation and Enabling Works Strategy document (Appendix 10.2).

Assessment Methodology and Significance Criteria

Study Area

- 10.13 The subject site is a large irregular shaped parcel of land located to the south of Cherryfield Drive in Kirkby.
- 10.14 The southern sector of the site comprises maintained grassland with an area in the southeast of the site having recently undergone the felling of semi-mature and mature trees. The central sector of the site is currently unmaintained vacant grassland. Within the north of the site, is an area of active car park and former roadways and hardstanding associated with previous development. Knowsley community College is located in the north west of the site.
- 10.15 There is an additional area of vacant land with areas of hardstanding associated with former development, with a small building fronting Cherryfield Drive.

Survey and Data Sources

- 10.16 The desk based assessment of ground conditions has been undertaken and a summary of this research is set out below together with a description of baseline conditions.
- 10.17 The information obtained and considered in the desk study includes historical Ordnance Survey maps, geological maps and memoirs, hydrological and hydrogeological records, environmental databases, coal mining and mineral extraction records and the results of the site investigations carried out previously near the site. The purpose of the desk study was:
- to establish the environmental setting of the site, particularly with regards to ground conditions including local geology, hydrology and hydrogeology;
 - to identify historic use or current potential sources of contamination and how these may affect the proposed scheme or indeed the wider environment;
 - to develop a Conceptual Site Model [CSM] of the site. This would be carried out in line with requirements of the Environmental Protection Act Part 2A (Ref 13.1) source-pathway-receptor '*pollutant linkage*' methodology;

- to undertake a geotechnical appraisal of the site and identify any site constraints and potential risks;
- to characterise, where possible, constraints and development considerations, including recommendations for further investigations, assessments and mitigation.

10.18 Ordnance survey maps, historical maps and environmental data have been obtained from a commercially available data provider (Landmark)

10.19 The environmental data obtained contains regulatory information from the following authorities:

- KMBC – air pollution controls, waste, contaminated land
- Environment Agency – waste, hydrogeological, hydrological, pollution
- Merseyside Waste Disposal Authority - waste
- Coal Authority – coal mining
- Natural England – sensitive sites, nature reserves
- Public Health England - radon
- Health & Safety Executive – COMAH permitted facilities

10.20 In addition to desk-based assessment, E3P has completed an intrusive ground investigation which comprised the following:

- 132 x mechanically excavated trial pits,
- 69 x window sample boreholes,
- 46 x Dynamic Cone Penetrometers,
- 11 x BRE365 Soakaway Tests,
- 3 x Cable Percussion Boreholes with Rotary Borehole follow on
- Construction of environmental monitoring installations.

10.21 Using data obtained from the intrusive ground investigation, E3P has completed a Tier I human health and controlled waters risk assessment in accordance with guidance presented with the EA publication LC:RM in order to develop a site Conceptual Site Model based on the presence of identified source-pathways and receptors.

Assessment of Effects

- 10.22 Based on the findings of the assessments the potential effects during the construction stage and the operational development have been evaluated using the method set out below and appropriate mitigation measures identified as necessary within the remediation and enabling works strategy.
- 10.23 The assessment includes consideration of any proposed earth works and the potential effects of the development activities on sensitive receptors such as groundwater, site workers and future residential end-users.

Identification of Sensitive Receptors

- 10.24 Table 10.1 provides a framework within which the sensitivity of receptors will be assessed. This part of the assessment will be based on professional judgement following a review of mapping and environmental data.

Table 10.1 Defining the Sensitivity of Receptors

Sensitivity	Definition
High	High quality watercourse, unprotected Principal Aquifer, potable groundwater abstraction, on-site operatives, residential properties, schools and hospitals within the site or within 250m of the site boundary.
Medium	Low quality watercourses, Secondary A Aquifer and residential properties, schools within 250m of the site boundary.
Low	Absence of surface watercourse, Unclassified Aquifer or low permeability drift and no sensitive land uses within 250m of the site boundary.

- 10.25 Table 10.2 provides a framework within which the magnitude of impact will be assessed during the construction and operational phases of the Proposed Development.

Table 10.2 Defining the Magnitude of Effect

Magnitude of Effect	Definition of Magnitude
High	Activities are likely to increase long-term contaminant release over and above the baseline conditions with significantly increased risks to human health and the wider environment. Effects are likely to be important considerations at a regional or district scale. Remedial work may mitigate such effects to some degree but is unlikely to remove all of the effects upon the affected receptors.
Medium	Activities are likely to result in significant contaminant release, or cause degradation of other soil quality parameters, over and above the baseline conditions, with significantly increased risks to human health or controlled waters. Effects could be permanent on a local scale or have wider, temporary impact. Remediation measures are likely to be largely effective although some residual effects may still arise.
Low	Activities may result in some contaminant release or cause degradation of other soil quality parameters over and above the baseline conditions with significant increased risks to human health or controlled waters. Effects are likely to be both temporary and local in nature and can be successfully addressed by remediation to leave minimal residual risk.
Negligible	No effect or effect where risks to human health or the wider environment are not significantly increased.

Significance Criteria

10.26 Table 10.3 provides a framework which allows for the magnitude of the likely impact to be combined with sensitivity of the receptor to determine the overall significance of the environmental effect. As much of the assessment is based on professional judgement following detailed review of published data this assessment will also be based on professional judgement. Effects considered to have Major Significance will be considered significant in EIA terms.

Magnitude of Effect	Sensitivity of Receptors		
	High	Medium	Low
High	Major	Moderate	Moderate
Medium	Major	Moderate	Minor
Low	Minor	Minor	None
Negligible	None	None	None

Assumptions/Limitations

- 10.27 Access was not available within the car park in the north of the site, or in the north-west of the site in the vicinity of the college and Covid-19 Testing centre due to their active nature. Areas of the northern sector of the site were limited in terms of access due to a high volume of services.
- 10.28 Investigation of the Electricity Substation on the northern boundary was not possible due to the live nature of infrastructure in this area.

Consultation

Table 10.4: Consultation

Consultee	Date and Time	Comments	Actions
Environmental Health Officer (EHO) – Knowsley Council	Contacted 5 th January 2022, with correspondence from EHO on 5 th January 2022. Clarifications on landfill	Contact was made prior to any site investigation works, when E3P was preparing to complete the site works and completing the Phase 1 Desk Study to obtain information from the council in relation to the site and surrounding area.	None Required.
Environment Agency	Contacted on the 30 th May 2022 to engage in paid consultation review of the site. Environment Agency were instructed on the 12 th August 2022 with a response		Assessment of impact from adjacent historical landfill onto the site and supply of detailed borehole plan.

Consultee	Date and Time	Comments	Actions
	provided on the 19 th August 2022. A call was completed on 18 th August 2022.		
Knowsley Council	Scoping Opinion 20 October 2022	Geology, Ground Conditions and Contamination to be scoped into the ES. Site investigation and risk assessment to be prepared including 12 months of gas monitoring. Ground gas monitoring currently on-going with final regime to be submitted on completion. Assessment of impact on controlled waters to be undertaken.	ES chapter prepared Site investigation included as Appendix 10.1 Assessment included within this chapter

Baseline Conditions

General History and Development

- 10.29 Historical mapping indicates that the site was undeveloped until the 1960s, with the subsequent construction of the college campus in the north-western sector and a school in the south-eastern sector. Circa 1961, historical mapping shows earthworks associated with the adjacent landfill site, by 1976 the landfill is no longer shown.
- 10.30 Residential dwellings and retail buildings, including a fuel station and electrical substations, are shown at the northern site boundary pre-1961.
- 10.31 Aerial imagery indicates the south-eastern sector of the site was cleared pre-2011; the hotel pre-2012; the residential housing pre-2015, the college in the north-west pre-2016; with the remainder of buildings in the north of the site demolished by pre-2019 and pre-2021.
- 10.32 There is currently no evidence of the fuel station above ground however it is understood the underground storage tanks are still present.
- 10.33 At present, the site is largely vacant, with the former roads and hardstanding at the north of the site and areas of car parking associated with the now-demolished school and college. A building associated with the former college remains in the north-western sector.
- 10.34 A review of geological map information indicates that drift strata beneath the site comprises Glacial Till across the majority of the site and Shirdley Hill Sand at the northern boundary. No drift deposits are recorded in the north-west of the site. The solid geological stratum beneath the site is mapped as the Chester Formation Sandstone.
- 10.35 The Glacial Till is classified as a secondary undifferentiated aquifer (drift) (low sensitivity) with the Shirdley Hill Sand classified as a secondary A drift aquifer (medium sensitivity). The bedrock stratum is classified as a principal aquifer (high sensitivity). No groundwater abstractions have been identified within a 1 km radius.
- 10.36 The Kirkby Brook is located 52m west to the site at a lower topographical gradient. The brook is assessed as being of medium sensitivity given its distance from the site.

Baseline Survey Information

- 10.37 The ground investigation works completed within the site have identified the following ground conditions.

Made Ground

- 10.38 Made Ground deposits were encountered within the majority of exploratory hole locations to depths of between 0.00m and 5.50 bgl. The depth of Made Ground was not proven in 20 locations due to either underground obstructions, the collapse of the trial pit, or the ingress of water.
- 10.39 Made Ground deposits generally comprised reworked topsoil of dark grey slightly gravelly clayey fine to coarse SAND or gravelly sandy to very sandy CLAY with frequent rootlets with gravel of brick, mudstone, sandstone and ceramic. TP164 was overlain by asphalt and concrete associated with the former garage/petrol station, with TP168 overlain by ceramic tiles overlying concrete indicative of the former residential dwellings in this area of the site. Furthermore, WS150, TP188 and TP196 in the north-east of the site was overlain by asphalt, with WS144, WS146, WS148, TP190, TP192 and TP194 overlain by concrete with rebar. TP197 and WS147 in the north-west of the site was overlain by asphalt and concrete.
- 10.40 Underlying the reworked topsoil or hardstanding, deeper Made Ground deposits comprised of reworked brown very sandy gravelly clays or gravelly sands.
- 10.41 Within TP160 the exploratory hole location was dug down the side of a former foundation which showed the slab to be 1.10m thick and the foundation going down to 2.80mbgl.
- 10.42 Made Ground deposits across the central and northern sector of the site comprised a clayey very gravelly fine to coarse ashy sand with gravel of ash, glass, ceramic, textiles, clinker, wood, timber, brick, metal, mudstone and cardboard. This material was considered to be incinerated materials utilised to create the level platform currently on site.

Drift

- 10.43 Drift deposits were encountered within the majority of exploratory locations with the exception of locations where the full depth of Made Ground could not be proven. The drift deposits are

varied, generally comprising a soft to very stiff, medium to very high strength, slightly gravelly sandy brown CLAY with gravel of sandstone and mudstone or a slightly gravelly to gravelly slightly, slightly clayey to very clayey fine to medium SAND with gravel of sandstone and mudstone.

Solid

- 10.44 The solid bedrock geology was first encountered between 4.70 mbgl and 6.10mbgl. and comprised of SANDSTONE.
- 10.45 A number of window sample probeholes terminated on or within weathered sandstone bedrock which was recovered as gravelly SAND from 1.20mbgl. to in excess of 5.45mbgl.

Value/Importance of Contaminated Land

- 10.46 Based on the findings of the ground investigation and subsequent laboratory chemical analysis, of soil and groundwater samples, a conceptual site model was developed that summaries the potential risk to human health (construction and occupational phase) and controlled waters (construction and occupational phases) based on a Source-Pathway-Receptor linkage assessment as per the requirements of EA guidance provided with LC:RM. The findings of the contaminated land risk assessment are summarised below.

Human Health

- 10.47 Elevated concentrations of heavy metals, mercury, non-volatile PAHs, naphthalene, asbestos and SVOCs have been identified within the soil analysis completed to date.
- 10.48 Heavy metals and non-volatile PAHs are considered to pose a risk to future end-users through dermal contact and ingestion. The risk can be mitigated through the installation of a cover system within garden and landscaping areas.
- 10.49 Mercury, naphthalene and dibutyl phthalate have been noted to be elevated in isolated locations across the site, and present a vapour risk to future end-users. It is recommended that a hotspot removal is completed and the materials either placed in an area of low sensitivity or removed from the site.

- 10.50 Within the soils analysis, no elevated concentrations of TPH or BTEX in the area of the former petrol filling station were identified to date. A hydrocarbon odour was identified within WS142 in this vicinity within SAND deposits underlying Made Ground. The tanks are understood to still be in-situ and the presence of contamination cannot be ruled out at this stage.
- 10.51 Asbestos, quantified between <0.001% and 0.005% has been identified within three locations at the site. As only trace fibres have been encountered, impacted soils and Made Ground will need to be placed in accordance with the asbestos conceptual site model with a suitable cover system placed in all garden and landscaped areas to prevent exposure to future site users. A hotspot removal should be completed in areas in which asbestos quantification is greater than 0.001%.

Controlled Waters

- 10.52 The assessment prepared in consideration of the developed CSM has not identified any potentially complete pollutant linkage or risk to controlled waters. Elevated TPHs against EQS screening values were identified in groundwater samples from WS142 in close proximity to the former petrol filling station, however concentrations did not exceed the DWS screening value in relation to the underlying principal aquifer which is considered to be the primary receptor in this instance.

Ground Gas

- 10.53 Ground gas monitoring to date has characterised the site as CS1 (low risk) with areas of Made Ground material adhering to a CS2 (low moderate) classification. It is recommended an allowance of CS2 protection measures are allowed for until the complete ground gas monitoring regime has been completed.

Embedded Mitigation

- 10.54 Based on the findings of the site investigation and subsequent contaminated land risk assessment, E3P developed a detailed Remediation and Enabling Works Strategy (Ref 15-280-R2-1, dated April 2022) that sets out all the measures that are needed to mitigate the identified risks. The mitigation measures are summarised below.

10.55 As the above mitigation measures will be required ahead of construction or occupation of dwellings, these are considered to be embedded mitigation. The works will be completed as part of an agreed remediation strategy and subject to planning condition.

- Implementing of all works in strict accordance with UK Environmental Permitting and local planning authority requirements.
- Controlled removal of all trees and vegetation.
- Removal and treatment of all invasive plant species (as required if identified) in accordance with a specialist contractor method statement, validation and independent certification.
- Further analysis of soils for PCBs in the vicinity of Electricity Substation when access is safe to do so.
- Segregation of organic topsoil deemed unsuitable for use within a residential garden and placement in an area of no sensitivity or removal from the site in accordance with UK waste management legislation.
- Decommission of all tanks and active drainage infrastructure in accordance with the contractor method statement and ensuring no environmental impact.
- Removal of materials locally impacted by TPH compounds within the immediate vicinity of the USTs filling infrastructure associated with the former garage/ fuel station.
- Management of all anthropogenic material impacted by trace asbestos fibre in a controlled and legislatively compliant manner.
- Mercury speciation to determine if elevated concentrations are deemed to be a volatile risk.
- Delineation and hotspot removal of naphthalene and Dibutyl phthalate impacted soils.
- Identification, delineation and removal of organic materials within infilled ponds.
- Removal of all structures, relict foundations and buried features in their entirety.
- Removal of all materials considered geotechnically deleterious.
- Excavation and processing of Made Ground in a controlled manner with the sorting, processing and segregation of identified deleterious materials to geotechnical specification specifically the lifting, processing and sorting of Made Ground within the area of historically deposited materials (ash / incinerated materials).
- Validation sampling and leachate testing to confirm material retained on-site poses no unacceptable risk to the residential end-users controlled waters or the wider environment.
- Importation of suitable material (if required) to achieve the required development levels.

- Replacement of material in accordance with the E3P enabling specification and engineering requirements for the specific end use.

10.56 The developer's works will also include the completion of the following additional elements:

- Provision of a 600 mm cover system using certified material with appropriate validation within proposed garden areas, comprising 450 mm subsoil (potentially site-won natural drift deposits) overlain by 150 mm topsoil.
- Provision of a 300 mm cover system using certified material with appropriate validation within proposed areas of public open space and soft landscaping.
- Construction of dwellings with appropriate gas mitigation to be compliant with CS2 pending completion of ground gas monitoring.
- Construction of appropriate potable water supply infrastructure.

Assessment of Likely Significant Effects

Construction

10.57 Provided that the measures specified within the remediation and enabling works strategy are followed all risks to human health and controlled waters during construction are considered to be negligible. Works to be completed are summarised within Section 10.60 and 10.61.

The Completed and Operational Development

10.58 Provided that the measures specified within the remediation and enabling works strategy are followed all risks to human health and controlled waters during the operational phase of the development are considered to be negligible.

Additional Mitigation / Enhancement Measures

10.59 None identified.

Residual Effects

10.60 Upon completion of the remediation and enabling works in line with the strategy, there will be no residual effects.

Description of Effect	Embedded Mitigation	Potential Effect (inc. Significance)	Further Mitigation	Residual Effect (inc. Significance)
Construction				
Excavation through potentially contaminated soils	Works to be completed in line with the Remediation Strategy	Negligible	Full CEMP to be constructed for all works on site.	Negligible
Controlled Waters	Works to be completed in line with the Remediation Strategy	Negligible	Full CEMP to be constructed for all works on site.	Negligible
Operation				
Residents exposed to contaminated soils in gardens and landscaped areas.	Works to be completed in line with the Remediation Strategy. Cover system into gardens and landscaped areas and ground gas mitigation measures where required.	Negligible	Building will be designed according to CIRIA 665 and BS8486 which will prevent ingress of ground gas. Cover systems to be designed in line with industry best practice. Mitigation measures to be validated in line with warranty providers (NHBC/LABC) requirements.	Negligible

Conclusions

- 10.61 E3P has undertaken a tiered risk assessment at the proposed development in accordance with EA guidance provided within LC:RM and has followed this with a remediation options appraisal that is included within an remediation and enabling works strategy.
- 10.62 Where potential risks have been identified within the generic quantitative risk assessment a method for mitigation has been specified to ensure that there is a negligible risk to site construction workers and to future end users.
- 10.63 The site investigation and remediation strategy documents have been issued to KBMC and EA and are pending approval, with further works being completed to satisfy the comments from the EA paid consultation.

Assessment of Cumulative Effects

- 10.64 There is limited potential for the Proposed Development to give rise to likely significant cumulative effects in combination with other committed developments. This is because, following the implementation of the mitigation measures set out below there will no residual effects attributable to the Proposed Development on ground conditions such that a 'contribution' to cumulative effects cannot occur.

List of Appendices

Appendix 10.1 - E3P Ltd Phase I and II Geoenvironmental Site Assessment Cherryfield Drive, Kirkby, Liverpool, L32 8RX. Report Reference 15-280-R1-1. Dated April 2022.

Appendix 10.2 - E3P Ltd Remediation and Enabling Works Strategy Cherryfield Drive, Kirkby. Report Reference 15-280-R2-2. Dated April 2022.