



Knowsley Metropolitan Borough Council

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# **WINDY ARBOR CAR PARK**

Interpretative Environmental Ground Investigation  
Report







Knowsley Metropolitan Borough Council

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## **WINDY ARBOR CAR PARK**

Interpretative Environmental Ground Investigation Report

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Knowsley Metropolitan Borough Council

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## **WINDY ARBOR CAR PARK**

### Interpretative Environmental Ground Investigation Report

WSP

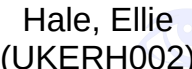
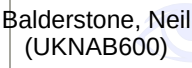
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# 1. INTRODUCTION

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## 1.1. TERMS OF REFERENCE

- 1.1.1. WSP has been commissioned by Knowsley Metropolitan Borough Council to prepare an Interpretative Environmental Ground Investigation Report to support a planning application for the proposed car park resurfacing and landscaping works at the Windy Arbor Playing Fields site.
- 1.1.2. The site is located at the edge of Whiston Cross and Halsnead Park, Knowsley, approximately 1.2km northeast of the M62/M57 motorway junction. National Grid coordinates are 346885 390498.

## 1.2. OVERVIEW OF THE PROPOSED SCHEME

- 1.2.1. The site is subject to a planning application for the resurfacing and landscaping of the existing car park which comprises the following:-
- Formal resurfacing of the parking area including the creation of forty vehicle spaces and forty cycle stands,
  - Widening of the existing access to allow separate vehicle and pedestrian entrances,
  - Installation of pedestrian access from Lickers Lane,
  - Soft landscaping around the hard standing area.

## 1.3. AIMS AND SCOPE

- 1.3.1. The aims of this interpretative report are to:
- Provide initial information on ground contamination to support the planning application,
  - Identify and assess potential constraints associated with ground contamination at the site which may impact the proposed scheme,
  - Consider the resulting implications of these in terms of the associated environmental requirements, risks and liabilities.
- 1.3.2. To assist in meeting the above aims, the scope of the assessment comprised:
- Preliminary Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment desk study carried out by WSP in October 2021,
  - Site walkover undertaken by WSP in June 2021,
  - Hand pitting and chemical testing undertaken by WSP in September 2021,
  - Window Sampling undertaken by MATtest Midlands Ltd with soil sampling undertaken by WSP in December 2021,
  - Laboratory chemical analysis of recovered soil samples,
  - Preparation of an Interpretative Environmental Report including generic quantitative risk assessment (GQRA), refinement of the preliminary conceptual site model (CSM) that was developed in the WSP Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment Report; and provision of recommendations with respect to the management and mitigation of any potential ground contamination constraints or liabilities which are identified.
- 1.3.3. This report forms part of the Health and Safety File for the site.

## 1.4. LEGISLATIVE CONTEXT AND GUIDANCE

- 1.4.1. The assessment was undertaken in the legislative context of:

- The National Planning Policy Framework (2012 as updated)

1.4.2. The following good practice and statutory guidance were considered and the assessment was undertaken in general accordance with:

- Environment Agency 'Land Contamination Risk Management' (LCRM) guidance (2020)
- CIRIA 'Assessing Risks Posed by Hazardous Ground Gases to Buildings', C665 (2007)
- British Standard 'Investigation of Potentially Contaminated Sites – Code of Practice', BS EN 10175:2011
- British Standard 'Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds (VOCs)' BS 8576:2013
- British Standard 'Code of Practice for Ground Investigations', BS 5930:2015

## 1.5. SOURCES OF INFORMATION

1.5.1. The following sources of information were used in the production of this report. Information from these sources relating to the underlying ground conditions has also been included in Sections 2 to 7 of this report where appropriate:

**Table 1 - Sources of Information**

| Source              | Report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WSP Reports         | <ul style="list-style-type: none"> <li>▪ WSP UK Ltd. Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment, October 2021.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Third Party Reports | <ul style="list-style-type: none"> <li>▪ MATtest Midlands Ltd. Borehole and trial pit ground investigation factual report, August 2020.</li> <li>▪ MATtest Midlands Ltd. Window sampling ground investigation factual report, December 2021.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Public Information  | <ul style="list-style-type: none"> <li>▪ GroundSure Enviro and Geo Insight report reference WSP-7961075 dated 16th June 2021.</li> <li>▪ BGS 'Geology of Britain' online viewer – <a href="http://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer">www.bgs.ac.uk/map-viewers/geology-of-britain-viewer</a></li> <li>▪ Zetica Unexploded Bomb Risk Map.</li> <li>▪ DEFRA MAGIC online portal, accessed June 2021. Available via: <a href="https://magic.defra.gov.uk/">https://magic.defra.gov.uk/</a>;</li> <li>▪ The Coal Authority Interactive Map Viewer accessed: June 2021. Available via <a href="http://mapapps2.bgs.ac.uk/coalauthority/home.html">http://mapapps2.bgs.ac.uk/coalauthority/home.html</a>.</li> <li>▪ The Governments Interactive Flood Risk Map accessed: June 2021. Available via <a href="https://flood-warning-information.service.gov.uk/long-term-flood-risk">https://flood-warning-information.service.gov.uk/long-term-flood-risk</a></li> </ul> |

## 1.6. CONFIDENTIALITY

1.6.1. This report is addressed to and may be relied upon by Knowsley Metropolitan Borough Council.

1.6.2. This assessment has been prepared for the sole use of the above-named party. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP. No responsibility will be accepted where this report is used in its entirety or in part, by any other party. Information provided by others is taken in good faith as being accurate. WSP cannot



and will not accept liability for any deficiencies in third party information. General limitations are presented in Appendix E.

## 2. SITE SETTING

### 2.1. SITE DESCRIPTION AND CURRENT USE

- 2.1.1. This Section, including Table 2 below, summarises the site details presented in the WSP Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment Report dated October 2021.
- 2.1.2. Drawing 70057126-Site Location Plan details the site location and redline boundary. Drawing 70057126\_WSP\_XX\_XX\_DR\_LA\_0002 details the proposed masterplan for the site. Both drawings are presented in Appendix A.

**Table 2 – Summary of Site Details**

| Aspect                            | Detail                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name and Address of site          | Windy Arbor Playing Fields Car Park.<br>Windy Arbor Road Playing Fields, Whiston, Prescot, L35 3PB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| National Grid reference           | 346885 390498                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Site Description and Current Use  | The Site is currently used as an informal car park for the neighbouring football club. The surface is uneven gravel (limestone and granite) hard standing that is in poor condition. Along the eastern boundary and along the southern boundary from the access gate are sections of asphalt. Along the western boundary, inside the boundary wall, is overgrown grassland. The northern section of the site is currently fenced off and used as a site compound and contains stockpiles of made ground from offsite. Adjacent to the site entrance in the southwest corner of the site is a Cadent Gas Ltd gas governor building. |
| Area                              | 0.2 ha                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Site Setting and Surrounding Area | The Site is bounded by the following land uses: <ul style="list-style-type: none"> <li>▪ <b>North</b> – Lickers Lane with housing beyond.</li> <li>▪ <b>East</b> – Windy Arbor Playing Fields with a few houses beyond and open land of Halsnead Park.</li> <li>▪ <b>South</b> – Windy Arbor Playing Fields including a pond with Main Drive and a brownfield site beyond.</li> <li>▪ <b>West</b> – Windy Arbor Road and with housing beyond.</li> </ul>                                                                                                                                                                           |
| Topography                        | Generally level site and surrounding area with slight downward gradient towards the southeast corner.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

### 2.2. SITE HISTORY

- 2.2.1. The earliest available historical Ordnance Survey mapping provided by GroundSure from 1850 shows the Site was an undeveloped part of the Halsnead Park estate grounds occupied by trees.
- 2.2.2. No significant changes occur until 1947 when the map shows the site is part of a recreation ground with a similar layout to the current day.

- 2.2.3. The earliest map provided by GroundSure Ltd from 1850 shows to the south and east of the site is Halsnead Park Estate parkland. To the north is Lickers Lane and the west is Tarbock Road. Land to the north and west outside the Halsnead Park Estate is agricultural with Whiston village 350m north.
- 2.2.4. Coal pits and collieries are recorded within 750m of the site but are generally classed as disused by 1891 and 1906.
- 2.2.5. By 1906 Whiston Metallic Brick Works is shown to be 250m west of the site.
- 2.2.6. The 1937 map shows residential development to the northwest of the site which continues expanding round to the west, north and northeast of the site.

## 2.3. POTENTIAL SOURCES OF CONTAMINATION

### ON-SITE CONTAMINATION SOURCES

- 2.3.1. The WSP Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment identified the following potential on-site sources of contamination:

**Table 3 – Areas of Potential Contamination (APC)**

| APC No. | APC Type                          | Anticipated Contaminants in Soil & / or Groundwater                                                                                  |
|---------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| APC1    | Made Ground across the site.      | Metals, polyaromatic hydrocarbons and asbestos. Although unlikely to be in high quantities because of previous undeveloped land use. |
| APC4    | Hazardous ground gas or mine gas. | Potential for hazardous ground gases within Made Ground and mine gas within underlying coal measures.                                |

### OFF-SITE CONTAMINATION SOURCES

- 2.3.2. Within the surrounding area, the following potential sources of contamination that could migrate onto the site are:
- Adjacent historical colliery or coal pit sites.
  - Adjacent historical Whiston Metallic Brick Works.
  - Adjacent agricultural land (pesticides and herbicides).

### 3. INTRUSIVE GROUND INVESTIGATION

- 3.1.1. Two phase of ground investigation have been undertaken in connection with the proposed scheme;
- MATtest Midland Ltd undertook an initial phase of ground investigation in August 2020. The works were designed by KMBC.
  - MATtest Midland Ltd undertook a second phase of ground investigation works in December 2021. These were designed by WSP Ltd after the monitoring wells from the 2020 investigation could not be located.
- 3.1.2. Appendix A presents Drawing 70057126\_WSP\_XX\_XX\_DR\_LA\_0002\_C01 B which indicates the location of the 2021 exploratory hole locations. Appendix B presents the factual ground investigation information for both phases of works.

### 3.2. 2020 MATTEST MIDLANDS LTD GROUND INVESTIGATION

- 3.2.1. The 2020 ground investigation was undertaken by MATtest Midlands Ltd in August 2020. Appendix B presents the factual ground investigation information provided by MATtest Midlands Ltd including engineer's logs, photo logs, dynamic cone penetration (DCP) test results, soakaway test data and soil infiltration rates. These works were instructed by KMBC for the purpose of providing information on the ground conditions at the site to inform the redevelopment works.
- 3.2.2. The scope of works comprised the following:
- 2 boreholes to 10m below ground level (bgl) with dynamic sampling and rotary follow on and installations for groundwater and ground gas monitoring.
  - 2 machine excavated trial pits to 4m bgl.
  - 4 machine excavated trial pits to approximately 1m bgl.
  - 1 machine excavated trial pit to approximately 1m bgl for CBR testing at ground level and the sub-soil.
  - 1 machine excavated trial pit to approximately 1m bgl specifically for a soakaway test.
- 3.2.3. No chemical testing was undertaken as part of this phase of works.
- 3.2.4. Table 3-1 below summarises the purpose of each exploratory location and confirms the sampling / testing undertaken.

**Table 3-1 – Exploratory Hole Summary (2020 Investigation)**

| Method                                | Exploratory Holes | Maximum Depth (m bgl) | Purpose                                                                                      | Monitoring Well                                              |
|---------------------------------------|-------------------|-----------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| Dynamic Sampling and Rotary Boreholes | BH101 and BH102   | 10                    | Confirm ground conditions. Install gas and groundwater monitoring wells.                     | 50mm standpipe. 0-1.0m bgl plain, 1.0m to 10.0m bgl slotted. |
| Machine Excavated Trial Pit           | TP101 and TP102   | 4                     | Confirm general ground conditions. TP101 dynamic cone penetrometer testing (DCP) undertaken. | N/A                                                          |
|                                       | TP1-TP4           | 1                     | Confirm general ground conditions. TP1 and TP3 soakaway testing. TP2 and TP3 DCP testing.    |                                                              |
|                                       | CBR Test          | 1                     | CBR test for surface soil and subsoil. DCP test.                                             |                                                              |
|                                       | Soakaway          | 1                     | Soakaway test undertaken.                                                                    |                                                              |

### 3.3. 2021 WSP GROUND INVESTIGATION

- 3.3.1. Hand pitting was undertaken by WSP in September 2021 at eight non-targeted locations across the site to obtain shallow soil samples for chemical testing from soft landscaping areas immediately adjacent to the hard standing.
- 3.3.2. MATtest Midlands Ltd undertook window sampling in December 2021 to provide a more comprehensive understanding of the ground conditions beneath the hard standing and to install new gas and groundwater monitoring wells to replace the two installations in BH101 and BH102 from the 2020 investigation which could not be found.
- 3.3.3. The scope of the works comprised:
- 5 window sample holes to a nominal 5m depth,
  - Chemical testing of selected soil samples,
  - Ground gas and groundwater monitoring wells installed in each window sampling location with five monitoring visits undertaken over a 5 week period post site works.
- 3.3.4. Selected soil samples from the hand pitting and window sampling were tested for the following suite of determinands:-
- Asbestos
  - Soil organic matter
  - Inorganics
  - Metals
  - Phenols
  - Gasoline Range Organics (GRO)
  - Total Petroleum Hydrocarbons (TPH)
  - Polyaromatic Hydrocarbons (PAH)
  - Polychlorinated Biphenyls (PCB)
  - Semi-Volatile and Volatile Organic Compounds
- 3.3.5. Chemical test results and factual information are presented in Appendix B.
- 3.3.6. Table 3-2 below summarises the purpose of each exploratory location and confirms the sampling / testing undertaken.

**Table 3-2 – Exploratory Hole Summary (2021 Investigation)**

| Method                   | Exploratory Holes | Maximum Depth (m bgl) | Purpose                                                                  | Monitoring Well |
|--------------------------|-------------------|-----------------------|--------------------------------------------------------------------------|-----------------|
| Window Samples           | WS01 to WS05      | 5                     | Confirm ground conditions. Install gas and groundwater monitoring wells. | 50mm standpipe. |
| Hand Excavated Trial Pit | TP1 to TP8        | 0.4                   | Confirm general ground conditions within the landscaping areas.          | N/A             |

## 4. GROUND CONDITIONS ASSESSMENT

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### 4.1. PUBLISHED GEOLOGY

4.1.1. The BGS on-line Geology of Britain Viewer indicates the underlying geology comprises the following;-

- Superficial Glacial Till underlain by bedrock comprising mudstone, siltstone and sandstone of the Pennine Middle Coal Measures Formation.

### 4.2. GROUND CONDITIONS ENCOUNTERED ON-SITE

#### Made Ground

4.2.1. Made ground was recorded on the Engineer's logs in all exploratory holes across the site and generally comprised three distinct soil types;-

- dark brown or black sandy gravel – generally recorded beneath the tarmac hard standing,
- grey mottled brown or yellow and black sandy, gravelly clay - probably reworked natural ground,
- dark brown clayey gravelly sand – reworked / poor quality topsoil around the edge of the existing hard standing.

#### Superficial Deposits

4.2.2. Superficial deposits of Glacial Till encountered as very stiff yellowish brown mottled orange and grey silty, sandy clay were recorded in all exploratory holes except WS04 (refused in made ground horizon). The minimum depth to the glacial till was 0.3m bgl.

#### Bedrock

4.2.3. Bedrock was encountered in deeper exploratory holes (BH101, BH102, TP101, TP102) during the 2020 ground investigation and is described as laminated, weathered mudstone from the Pennine Middle Coal Measures Formation. The minimum depth to bedrock was 2.0m bgl in BH102, although it should be noted that WS01 is located within 1m of BH102 and recorded glacial clay to at least 5m below ground level.

#### Visual and Olfactory Evidence of Contamination

- 4.2.4. No olfactory evidence of contamination was recorded.
- 4.2.5. Visual evidence of man-made detritus recorded as gravel within the made ground comprised tarmac, brick and pottery. In addition, other man-made detritus comprised metal, a battery, a crisp packet and other plastic detritus.
- 4.2.6. Stockpiles of made ground containing tarmac, paving slabs, concrete and bricks from the adjacent highway works are temporarily stockpiled in the compound at the northern edge of the site. Assessment of these stockpiles is outside the scope of this report.

#### Monitoring Wells

- 4.2.7. Monitoring wells were installed in each of the window samples during the 2021 investigation. In addition, the two monitoring wells installed in 2020 by MATtest Midlands Ltd. (BH101 and BH102) were rediscovered during the 2021 site works.
- 4.2.8. Full details of each installation are shown on the Engineer's logs in Appendix B.

### **Gas Monitoring**

- 4.2.9. Gas monitoring was undertaken on 5 occasions at approximately weekly intervals following completion of the drilling works. The maximum concentration of carbon dioxide recorded was 9.4% (BH102). No methane, hydrogen sulphide or carbon monoxide was recorded. Steady flow rates varied from -3.9 litres per hour to 1.8 litres per hour. The full results are presented in Appendix B.

### **Groundwater Monitoring**

- 4.2.10. Groundwater levels were monitored on the same five occasions the gas monitoring was undertaken. The site has a slight slope towards the southeast corner and this is reflected in the groundwater levels as groundwater is encountered at approximately 1m bgl in WS02, WS03, WS04 and WS05 (towards the southeast) and deeper in the northwest corner at WS01 (2.6-4.0m bgl) and BH102 (4.7-5.1m bgl). No groundwater was encountered in BH101 despite its proximity to WS01 where groundwater is encountered between 2.6 and 4.0m bgl. Groundwater levels within each well fluctuated over the monitoring period (sometimes by up to 2m), probably as a result of heavy rain events and differences in strata permeability. The full monitoring results are presented in Appendix B.

## 5. HYDROLOGICAL & HYDROGEOLOGICAL CONDITIONS

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### 5.1. LOCAL HYDROLOGY

- 5.1.1. There are no surface water features on site. A pond is located 160m south of the site.
- 5.1.2. There are no surface water abstractions on site.
- 5.1.3. The risk of flooding on site from surface water is negligible.
- 5.1.4. The site is within a Nitrate Vulnerable Zone relating to Ditton Brook and the surface water body catchment zone of influence, as defined by the Water Framework Directive (WFD), for Prescott Brook approximately 900m west.

### 5.2. HYDROGEOLOGY

#### GEOLOGY AND AQUIFER STATUS

- 5.2.1. The superficial glacial till deposits, which underlie the Site, are classified as a Secondary (Undifferentiated) Aquifer. The Pennine Middle Coal Measure Formation bedrock beneath this is classified as a Secondary A Aquifer.
- 5.2.2. There is a low risk of groundwater flooding on the site.
- 5.2.3. There are no groundwater or potable water abstractions on site or within 500m of the site.
- 5.2.4. The soils on site, superficial and bedrock geology have a low leaching potential.
- 5.2.5. The site is not within a Source Protection Zone.

## 6. QUANTITATIVE RISK ASSESSMENT

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### 6.1. INTRODUCTION

- 6.1.1. In the United Kingdom, the presence of contamination within soil or groundwater at a Site is generally only of concern if an actual or potentially unacceptable risk to a sensitive receptor exists.
- 6.1.2. The risk assessment process begins with screening chemical concentrations in soil or groundwater against conservative screening values, a process called Generic Qualitative Risk Assessment (GQRA). GQRAs are performed to assess the potential risks to human health and controlled waters and to identify the presence of contaminants of concern (CoC), which may require further, more detailed assessment.
- 6.1.3. Appendix B presents the chemical test data and Appendix D presents the screening spreadsheets.

### 6.2. HUMAN HEALTH RISK ASSESSMENT

#### RATIONALE

- 6.2.1. Following the tiered approach which is described in Land Contamination Risk Management (LCRM) guidance published by the Environment Agency, this Section provides a GQRA of those contaminant linkages that were determined to be plausible in the preliminary CSM.
- 6.2.2. Defra and the Environment Agency have published a limited number of Soil Guideline Values (SGVs) for a series of generic land use scenarios which follow the Contaminated Land Exposure Assessment (CLEA) methodology. Where SGVs are not available, WSP has derived a set of Generic Assessment Criteria (GAC) for the CLEA generic land use scenarios using the CLEA Workbook v1.071 Excel modelling tool. The CLEA workbook does not currently have the capacity to derive criteria to assess risks from the inhalation of vapours derived from contaminants dissolved in groundwater. Therefore, a set of groundwater GACs has also been derived using the Johnson & Ettinger (J&E) approach.
- 6.2.3. The chemical test results have been assessed against screening values for a public open space land use scenario as this is most appropriate for the proposed car park and associated soft landscaping redevelopment scheme. Further details in the methodologies adopted by WSP Ltd are provided in Appendix C. These land use scenarios are also defined in the Environment Agency document 'Updated Technical Background to the CLEA Model' Report SC050021/SR3, January 2009.
- 6.2.4. The average soil organic matter (SOM) concentration is 16.29% and therefore the soil chemical data has been compared against end use GACs with the highest SOM content which is 6%. Determinands that exceed their screening value are identified as CoC (contaminants of concern) and the samples they are present in are carried forward for further discussion.
- 6.2.5. For some CoC, direct contact will be the dominant pathway for exposure. The exact nature of soil excavation and reuse on this site is not known at this stage. However for the purpose of this report to enable risk from contaminated soils to be assessed it is assumed all soil will remain on site, deep excavation is not anticipated and the proposed redevelopment will leave the majority of the soil covered by tarmac.

## ASSESSMENT OF RESULTS – PUBLIC OPEN SPACE LAND USE SCENARIO

- 6.2.6. Four exceedances of the public open space land use screening values were recorded and are detailed below.

**Table 6-1 – Public Open Space Land Use Exceedances**

| Determinand           | Location | Screening Value (mg/kg) | Screening Value Source | Exceedance (mg/kg) |
|-----------------------|----------|-------------------------|------------------------|--------------------|
| Arsenic               | WS02     | 168                     | WSP   PB GAC v1        | 169                |
| Lead                  | WS02     | 808                     | WSP   PB GAC v1        | 875                |
| Benzo(a)pyrene (PAH)  | WS02     | 11                      | WSP   PB GAC v1        | 19.9               |
| Benzo(a)pyrene (SVOC) | TP2      | 11                      | WSP   PB GAC v1        | 20.6               |

- 6.2.7. Asbestos was not detected in any of the 13 samples for which it was tested.

- 6.2.8. No other contaminants of concern were identified.

## 6.3. CONTROLLED WATERS RISK ASSESSMENT

### METHODOLOGY

- 6.3.1. The generic controlled waters risk assessment was conducted in accordance with the principles of the Environment Agency publication 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination' 2006 (EA 2006) and the 'prevent and limit' approach of the Water Framework Directive (2000/60/EC). Generic controlled waters risk assessments compare directly measured concentrations with standard assessment criteria. In this case the following assessments were undertaken:
- Level 1 - evaluates the concentrations of chemicals within the pore water in the unsaturated zone of source area soil, in this case soil leachate analysis/using theoretical calculations.
- 6.3.2. Appropriate Water Quality Standards (WQS) are selected based on both a hierarchy of relevance to England and Wales and the receptor. In this case, the controlled water receptors identified in the CSM are:
- Surface water; an adjacent pond and two nearby brooks which lie within the site's zone of influence;
  - The underlying Secondary (Undifferentiated) and Secondary A Aquifers within the superficial and bedrock strata;
- 6.3.3. The following hierarchies of WQS were therefore considered to be appropriate:

### Aquifers

- UK Drinking Water Quality Standards (DWS) from The Water Supply (Water Quality) Regulations 2000 (amended 2004)
- World Health organisation Drinking Water Guidelines 2017,
- World Health Organisation Petroleum Products in Drinking Water (2008)

## Surface Waters

- Environmental Quality Standards (EQS) from The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
- CL:AIRE Petroleum in Groundwater Guidance 2017,

6.3.4. The following Sections detailing the determinands recording test results in excess of the WQS screening values should be read in conjunction with the screening tables presented in Appendix D.

## RISKS TO AQUIFER

### Soil Leachability Testing

6.3.5. Generic screening of 8 soil leachate test results from the September 2021 investigation identified exceedances of the WQS screening values for benzo(a)pyrene in 5 locations across the site with results varying from 0.0109µg/l to 0.0685µg/l compared to a screening value of 0.01µ/l.

6.3.6. No other contaminants of concern were identified.

## RISKS TO SURFACE WATER

### Soil Leachability Testing

6.3.7. Generic screening of 8 soil leachate test results from the September 2021 WSP ground investigation identified the following WQS exceedances;

**Table 6-2 - WQS Soil Leachate Exceedances (Risks to Surface Water)**

| Determinand    | Exceedence                 | Screening Value (ug/l) | Source of Screening Value | Number of Exceedences |
|----------------|----------------------------|------------------------|---------------------------|-----------------------|
| Cadmium        | 0.0837ug/l - 0.131ug/l     | 0.08                   | EQS                       | 3                     |
| Chromium       | 5.72ug/l - 8.02ug/l        | 4.7                    | EQS                       | 4                     |
| Copper         | 0.0019mg/l - 0.021mg/l     | 0.001                  | EQS                       | 6                     |
| Lead           | 0.00261mg/l - 0.00655mg/l  | 0.0012                 | EQS                       | 5                     |
| Nickel         | 0.00459mg/l - 0.00809mg/l  | 0.004                  | EQS                       | 4                     |
| Zinc           | 0.0128mg/l - 0.112mg/l     | 0.0109                 | EQS                       | 4                     |
| Benzo(a)pyrene | 0.00511 ug/l - 0.0685 ug/l | 0.00017                | EQS                       | 6                     |
| Fluoranthene   | 0.00861 ug/l - 0.312 ug/l  | 0.0063                 | EQS                       | 6                     |

6.3.8. It should be noted that the limits of detection for total cyanide, total phenols, aromatic hydrocarbons EC<sub>10</sub>-EC<sub>12</sub>, EC<sub>12</sub>-EC<sub>16</sub>, EC<sub>16</sub>-EC<sub>21</sub>, EC<sub>21</sub>-EC<sub>35</sub> and benzo(a)pyrene at location TP4 and TP6 exceed the screening values. It is therefore considered unlikely that unacceptable concentrations of these determinands exist that could pose a risk to the surface water receptor.

## 6.4. GROUND GAS ASSESSMENT

6.4.1. Gas monitoring was undertaken on 5 occasions at approximately weekly intervals following completion of the drilling works. The maximum concentration of carbon dioxide recorded was 9.4% (BH102). No methane, hydrogen sulphide and only very low concentrations of carbon monoxide

(10ppm at one location recorded for 1 monitoring round) was recorded. Steady flow rates varied from -3.9 litres per hour (WS05) to 1.8 litres per hour (BH101) and is likely to be due to variations in ground water level as a result of rainfall. The results are presented in Appendix B.

- 6.4.2. The monitoring has indicated there are no significant concentrations of methane and very little carbon dioxide. Therefore, the proposed resurfacing and landscaping scheme is not considered likely to result in any changes in the gas regime beneath the site that could affect neighbouring housing.

## **7. WASTE ASSESSMENT**

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### **7.1. HAZARDOUS PROPERTIES ASSESSMENT**

- 7.1.1. A waste classification hazardous properties assessment has been carried out in accordance with the WM3 Technical Guidance, to determine if the Site soils contain any hazardous properties.
- 7.1.2. The soil chemical test results from the 2021 ground investigation have been assessed and no hazardous properties were identified. The Haz Waste Online output report is presented in Appendix D.
- 7.1.3. Material classified as not containing hazardous properties is likely to be classified under the European Waste Catalogue (EWC) as '17 05 04 Soil and stones other than those mentioned in 17 05 03'.
- 7.1.4. The construction Contractor will need to make their own assessment of the waste classifications and any soils requiring offsite disposal will require further testing, likely to include waste acceptance criteria testing, to confirm an appropriate disposal route.

## 8. REFINED CONCEPTUAL SITE MODEL

### 8.1. INTRODUCTION

- 8.1.1. This Section provides a refinement of the preliminary CSM from the WSP Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment dated October 2021. From the information identified during the ground investigations and the risk assessments detailed in Section 6 above, plausible source-pathway-receptor contaminant linkages have been refined in line with industry good practice and guidance (principally LCRM and CIRIA 552).
- 8.1.2. The refined CSM provides an updated understanding of the site based on the findings of the ground investigations and analytical results and draws on the ground, hydrogeological and contamination models.

### 8.2. PLAUSIBLE CONTAMINANT LINKAGES

- 8.2.1. Table 8-1 presents a revised evaluation of the potential contaminant linkages that were considered to be plausible for the future use of the Site. It uses the recent ground investigation findings to refine the preliminary CSM presented in the WSP Phase 1 Geo-Environmental Assessment and Coal Mining Risk Assessment.

**Table 8-1 – Summary of Plausible Contaminant linkages**

| Potential Contaminants                                   | Potential Pathways                                                       | Potential Receptors                                                                                             | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Consequence of Risk Being Realised | Probability of Risk Being Realised | Qualitative Risk Ranking |
|----------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------|--------------------------|
| Contaminated made ground, potential to include asbestos. | Direct contact, ingestion or inhalation of soil bound contaminants/dust. | Construction / maintenance workers, adjacent site users and residents (during construction), future site users. | No asbestos was recorded. Minor exceedences for arsenic, lead and benzo-a-pyrene. No specific contaminant sources have been identified. The site's future use means pathways for soil bound contamination are limited as the tarmac surface of the car park will act as a barrier limiting soil exposure to the small areas of soft landscaping.                                                                                                                    | Minor                              | Likely                             | Low                      |
|                                                          | Inhalation of vapours from volatiles in soil.                            | Construction workers in deep excavations.                                                                       | No significantly elevated concentrations of volatile contaminants were recorded. The redevelopment of the car park will not require any deep excavations of enclosed spaces, so vapour accumulation or inhalation is not a risk during construction                                                                                                                                                                                                                 | Minor                              | Unlikely                           | Very Low                 |
|                                                          | Leaching of contamination to controlled waters/wider environment.        | Aquifers, surface waters                                                                                        | Chemical testing shows a number of contaminants have the potential to impact surface waters, however their concentrations are also low and the distance to receptors means there is no unacceptable risk.                                                                                                                                                                                                                                                           | Mild                               | Unlikely                           | Very Low                 |
| Hazardous ground gas or mine gas.                        | Migration and inhalation (asphyxiation) or explosion.                    | Construction workers (deep excavations), adjacent residential properties.                                       | No mine gas emissions have been recorded in the past. No deep excavations are required during construction or enclosed spaces proposed in the redevelopment so the risk of asphyxiation/inhalation/explosion of gas is negligible. The gas monitoring revealed no hazardous gases are present in the site's subsurface and the carbon dioxide level is acceptable. Therefore, the risk to changes in gas migration affecting neighbouring properties is negligible. | Mild                               | Unlikely                           | Very Low                 |

## 9. CONCLUSIONS AND RECOMMENDATIONS

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### 9.1. ENVIRONMENTAL / CONTAMINATION ASSESSMENT

- 9.1.1. The following potential contamination issues have been identified;
- Arsenic, lead and benzo-a-pyrene concentrations in excess of human health screening values at one location, with a second location also recording benzo-a-pyrene in excess of the screening value.
- 9.1.2. Benzo(a)pyrene has the potential to leach and could impact aquifer water beneath the site and various metals, benzo(a)pyrene and fluoranthene have the potential to leach and could impact surface water. However, the low concentrations of these identified contaminants, the future land use of the site, the nature of the aquifers and the distance to surface water features means there is unlikely to be an unacceptable risk to controlled waters from these determinands.
- 9.1.3. The gas monitoring undertaken recorded insignificant concentrations of methane, hydrogen sulphide or carbon monoxide. Carbon dioxide concentrations up to 9.4% were recorded but flow rates were very low. Given the low sensitivity of the end use which is unchanged from the existing end use, the low flow rates and the widespread presence of coal measures beneath the wider area, the site and the proposed works are not considered to pose an unacceptable risk to surrounding properties.

### 9.2. OUTLINE REMEDIAL MEASURES

- 9.2.1. Most of the site soils are chemically suitable for re-use within the scheme, either in soft landscaping areas or beneath hard standing.
- 9.2.2. However, soils from WS02 and TP02 are not chemically suitable for re-use within the soft landscaping where there is a potential contamination pathway to human receptors. Soils from these two locations could be reused beneath hard standing or beneath a sufficiently thick inert topsoil layer, both of which would break the contamination linkage minimising the potential risk to human health.

### 9.3. CONSTRUCTION CONSIDERATIONS

- 9.3.1. Protection of construction workers, site users and adjacent site users from airborne dust generated during construction will be required.
- 9.3.2. The construction Contractor will need to keep a 'watching brief' for unforeseen contamination including asbestos.

#### RE-USE OF SITE WON SOILS

- 9.3.3. Re-use of site won soils within the scheme could be undertaken under an MMP prepared in accordance with the CL:AIRE Definition of Waste Code of Practice or similar protocol. The materials for re-use within the Proposed Scheme would need to meet the following criteria;-
- A defined end use,
  - A defined volume, and
  - The material needs to be chemically and geotechnically suitable for the intended use.
- 9.3.4. Alternatively, an Environment Agency U1 exemption could be used to manage re-use of soils in the construction works where volumes are small.

- 9.3.5. It is recommended that site won topsoils are re-tested to confirm suitability for re-use within the scheme prior to placement in the landscaping areas.

## **9.4. RISK REGISTER**

- 9.4.1. It is recommended that unforeseen ground conditions are included as a risk on the project risk register and that all parties involved in the scheme including construction are aware of the potential for further materials to be present that are unsuitable for re-use and therefore require disposal offsite to a suitably licensed facility.

# Appendix A

## DRAWINGS

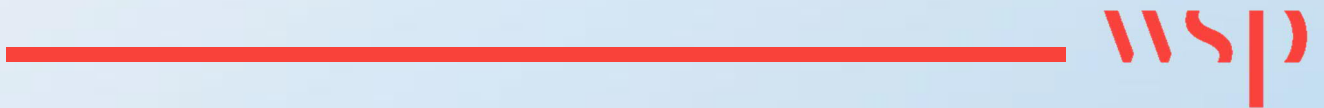
# Appendix B

## GROUND INVESTIGATION FACTUAL INFORMATION



# Appendix C

## HUMAN HEALTH RISK ASSESSMENT BACKGROUND INFORMATION



# Appendix D

## RISK ASSESSMENT SCREENING SPREADSHEETS



# Appendix E

## GENERAL LIMITATIONS





1st Floor Station House  
Tithebarn Street, Exchange Station  
Liverpool  
L2 2QP

**wsp.com**