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Remediation Strategy
For former British Airways and Vodafone Plots

Former British Airways and Vodafone Plots, North Hyde Gardens, Hayes, UB3 4QQ

A REPORT PREPARED

FOR AND ON BEHALF OF ARK DATA CENTRES LIMITED

C/O HURLEY PALMER FLATT

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	For and on behalf of Paragon Building Consultancy Limited

NON-TECHNICAL SUMMARY

KEY POINTS

	Background
1.	The development site is situated within the wider Bulls Bridge Industrial Estate in Hayes, for which Ark Data Centres are the current freeholder. The client, Hurley Palmer Flatt (HPF) has been appointed as the structural engineer for the development of a data centre with a Hydrotreated Vegetable Oil (HVO) energy centre on the former British Airways (BA) plot and a substation on the former Vodafone plot. Planning permission was granted for this development by the London Borough of Hillingdon under planning reference 75111/APP/2020/1955.
2.	The wider industrial estate comprises five main parcels of land that are referred to throughout this report as: Vodafone, British Airways (BA), Abellio, Addison Lee and Conway (Maintenance Yard). Neither the FM Conway nor Addison Lee plots are subject to this application. The access road: North Hyde Gardens is also within the wider site's demise. The development site for this application includes the Vodafone and BA plots only and it is relatively flat with reduced elevations in the eastern part of the site where the River Crane (also known as the Yeading Brook) runs. In addition, the Grand Union Canal is off site and located within 5m of the southern boundary of the Vodafone plot.
3.	This document has been prepared to discharge Condition 33 for planning ref. 75111/APP/2020/1955. As agreed with the London Borough of Hillingdon, given the above, the approach taken is for Condition 33 to be discharged in connection to the whole site with the exception of the Abellio plot. The overall effect is that Condition 33 will be partially discharged. The documentation is also used for the discharge of Condition 31 (1C).
4.	Paragon has completed earlier Phase 1 and Phase 2 investigations which form the basis of this strategy and a conceptual site model (CSM) has been formulated from these earlier phases of work.
5.	The Phase 1 assessment identified that the site has a history of being used as a creosote works, an oil fired power station and a former railway. It is also understood from British Geological Survey (BGS) mapping that the site comprises artificial ground, which is presumed to be from informal landfilling at the site.
6.	The Phase 2 investigations comprised a series of exploratory holes. The results of these investigations identified asbestos fibres within the Made Ground, exceedances of contaminants within the groundwater and potential for ground gas and vapour.
	Ground Conditions
7.	The British Geological Survey (BGS) mapping for the site identified it is underlain by the Lynch Hill Gravel Member, over the London Clay Formation. The boreholes drilled onsite encountered hardstanding over Made Ground (cohesive and granular lenses) to a maximum depth of 5.8mbgl over Lynch Hill Gravel (cohesive and granular lenses) to 10.2mbgl over London Clay Formation to a maximum drilled depth of 35mbgl.

8.	Groundwater was encountered in the Lynch Hill Gravel at around 29mAOD in the centre of the site and closest to the river at 26.76-26.57mAOD. In comparison, the base of the River Crane channel adjacent to the site is around 25.00mAOD based on Environment Agency LiDAR data. Perched groundwater was also encountered in the Made Ground and London Clay.
	Environmental Findings
9.	The soil and groundwater samples recovered from the boreholes were submitted for laboratory testing for a range of contaminants in line with the historical uses of the site and findings of the previous investigations.
10.	The results identified asbestos fibres were present within the shallow Made Ground across the site. The extensive hardstanding mitigates risks to site users in the current site layout, however when construction commences and hardstanding is broken out there will be a potential release of fibres to air. As such, careful management of the soils will be required throughout the construction phase to mitigate risks to construction workers and off-site receptors.
11.	The concentrations of Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) within the groundwater exceeded the Environmental Quality Standard (EQS), which was used to assess the risks to the River Crane/Yeading Brook (considered the most sensitive Controlled Water assessment). However, a Detailed Quantitative Risk Assessment (DQRA) was subsequently undertaken using the Remedial Targets Methodology which has shown that the site does not pose any significant risks to Controlled Waters (River Crane). As such, following the site investigations and DQRA undertaken to date it is considered unlikely that the contamination identified in site soils or groundwater would warrant remediation. Also, due to the presence of high levels of Ammonia already in the River Crane, it is unlikely that any remediation carried out on the Bulls Bridge would result in a measurable benefit to the River Crane.
12.	The results from the gas monitoring and vapour analysis have identified slightly elevated concentrations of carbon dioxide, and elevated concentrations of the naphthalene in one location. As such, there is a potential gas and vapour risk.

RECOMMENDATIONS

Remediation Strategy

1. The chemical analysis has identified asbestos within the soil and elevated concentrations of TPH and PAH within the groundwater. In addition, a potential gas and vapour risk has been identified. These impacts are considered to relate to the historical development of the site, which has a longstanding industrial legacy as a creosote works and power station. Therefore, to facilitate the future development, the following recommendations are made:

- Site clearance and demolition including the removal of the generator / above ground tank in the Vodafone plot (completed in spring / summer 2020);
- Personal Protective Equipment and health and safety controls;
- Watching brief and discovery strategy in the event that previously unidentified contamination is encountered;
- Ongoing monitoring of groundwater (a monitoring plan is included within this strategy);
- Capping layers in soft landscaped areas;
- Gas (methane and carbon dioxide) and vapour resistant membranes within future enclosed structures;
- Asbestos control measures and materials management;
- Barrier pipework for new drinking water supply pipework;
- Decommissioning of boreholes; and
- Piling Works Risk Assessment; and
- Remediation and Verification reporting.

Verification Plan

2. To confirm that the mitigation measures outlined by the Remediation Strategy are implemented, a Verification Plan has been produced and is included in detail within the following report. The strategy sets out the requirements of the main contractor(s) in terms of collating information during development and the responsibilities of an environmental consultant in reporting the findings of third-party verification activities. The verification plan involves:

- Recording the findings of a watching brief and any onsite control measures such as dampening down;
- Recording findings and outcomes of a discovery strategy should unforeseen contamination be encountered;
- Provision of completion report for the removal of the tank and decommissioning records;
- Findings of inspections and compliance testing;

	• Maintenance and provision of duty of care records (for importation and exportation of materials); • Site photographs; • Provenance data for topsoil / subsoil; • Chemical analysis data of soils and ongoing groundwater and surface water sampling; • Verification records of gas / vapour protection including specification of the design and As Built drawings; • Concrete design specification; • Borehole decommissioning information; • Confirmation of drinking water supply pipework material used and records of any communication with the local water supply company; and • Records of any permits / exemptions (if relevant).
3.	Periodic site audits would be required to ensure adequate site records and documentation are being maintained during demolition and construction works. There would need to be regular communication between the environmental consultant and the main contractor(s). The purpose of the verification plan is to produce a final Verification Report, which provides an accurate record of the final land quality as per the requirements of statutory guidance. The report would seek to demonstrate that remediation is successful in addressing the risks raised by the Conceptual Site Model.
	Regulatory
4.	This Remediation Strategy should be submitted to the Local Planning Authority For their comments and approval.

CONTENTS

REMEDIATION STRATEGY

CLIENT NAME:	Ark Data Centres Limited c/o Hurley Palmer Flatt
PROPERTY ADDRESS:	Former British Airways and Vodafone Plots North Hyde Gardens, Hayes
INSPECTION DATE:	N/A

1.0 INSTRUCTIONS

1.1	Paragon Building Consultancy Limited were instructed by Ark Data Centres Limited c/o Hurley Palmer Flatt on 10 January 2020 to produce a remediation strategy for a site referred to as Former British Airways and Vodafone Plots, North Hyde Gardens, Hayes, UB3 4QQ. This strategy has been produced following phases of ground investigation and has been completed in connection with redevelopment of the site as a data centre with an HVO energy centre and substation.

2.0 AIMS AND OBJECTIVES

2.1	This report has been prepared to discharge Condition 33 of the planning application ref. 75111/APP/2020/1955 to cover the British Airways and Vodafone plots. A Remediation Strategy is to be prepared for the Abellio plot separately. The aims of this report are: • To provide a summary ground conditions and geoenvironmental information that has been collated for the site. • To assess the potential mitigation measures required to address health and environmental risks associated with the development. • To provide remediation recommendations in relation to the proposed development.
2.2	The objectives of this report are to: • Provide the strategy for remediation at the site. • Provide details of verification procedures that will be adopted during the remediation works.

3.0 SCOPE OF WORKS

3.1	The remediation strategy has been completed in general accordance with Stage 3 of Land Contamination Risk Management 2020 and the Environment Agency document 'Verification of Remediation Land Contamination Report', SCO30114/R1, February 2010. Due regard is made to the Environmental Protection Act (EPA) 1990 Part 2A.
3.2	The following reports have been used to provide supporting information for this document; all of the reports are referenced for the site address Bulls Bridge, North Hyde Gardens, Hayes, UB3 4QQ: • Paragon (2019) Phase 1 Preliminary Risk Assessment, ref 19.0633/CB/NW dated 29 August 2019 – Rev D, Revised November 2021 (for planning purposes). • Paragon (2020) Phase 2 Ground Investigation Report, ref 20.0023, dated 6 March 2020 – Rev D, Revised November 2021. • Paragon (2020) Detailed Quantitative Risk Assessment (DQRA), ref 20.0023/CK/KJH dated 10 July 2020 – Rev C, Revised November 2021.
3.3	It is intended that this report be submitted in support of a planning application for the development of a data centre with an HVO energy centre and substation at the above mentioned site.

4.0 INTRODUCTION

4.1	**Site Location**
4.1.1	Previous Phase 1 and Phase 2 investigations have been reported separately by Paragon as referenced above. The original Phase 1 should be read in conjunction with this report; the following is a summary.
4.1.2	The site is centred around National Grid Reference 510423, 179309 and is approximately 3.5Ha. The approximate elevation of the site is 31m Above Ordnance Datum (mAOD). Site information gathered during the preliminary report is summarised below and a Site Location Plan is provided as Figure 1 in Appendix 1.
4.1.3	The wider site outlined in the previous investigation comprised five main parcels of land and access roads that are predominantly used for commercial and industrial uses, which are summarised below. • Vodafone; • British Airways (BA); • Abellio Bus Garage (Abellio) (not in current proposals); • Addison Lee (not in current proposals); and • FM Conway (not in current proposals).

4.1.4 The 2020 investigation by Paragon included drilling boreholes within the Vodafone and British Airways (BA) plots. A summary of each parcel of land is described below.

Table 1. Occupant Descriptions

Occupant	Brief description of site activities
Vodafone	The building on the Vodafone plot has now been demolished. At the time of the Phase 2 investigation the plot comprised a detached office block arranged over three floors with a reception atrium at ground floor and a roof terrace at 3rd floor level. At the time of the fieldwork the building was vacant and has recently been occupied by travellers. There was a redundant diesel powered generator on site, which has now been removed.
British Airways	The building onsite was demolished in 2019 and this area is an open area of land with a large stockpile of crushed concrete in the centre.

4.1.5 The River Crane (also known as the Yeading Brook) runs within the wider site boundary, along the southeast boundary and north through the northeast part of the site (Conway's plot). The Grand Union Canal is off site and located within 5m of the southern boundary of the site.

4.1.6 Vegetation was noted along the banks of the River Crane, which made access difficult in that area. A chain link fence was noted at points along the channel.

4.1.7 The most recent investigation (January 2020) included additional testing of the ground within the BA plot and the Vodafone plot only.

4.2 Proposed Development

4.2.1 The proposed development includes:

Site clearance and preparation, including the demolition of remaining buildings, and the redevelopment of the site to provide: a new data centre, an HVO Energy Centres, an HV Sub-Station, a visitor reception centre, plant, the creation of a new footpath and cycleway link to the canal towpath, works to the highway, car parking, cycle parking, associated infrastructure, enclosures and necessary physical security systems, hard and soft landscaping (including works to the River Crane) and ancillary uses, as well as associated external works

It is proposed to develop a data centre and an HVO energy centre on the former BA plot and a substation is to be constructed on the Vodafone plot. The Addison Lee and FM Conway plots are situated to the west and east of the BA plot respectively and the Abellio plot is to the south of the BA plot, however these are not within the red line for this planning application.

4.2.2 Proposed development plans have been provided by the client and a proposed layout plan is provided as Figure 2 in Appendix 1.

4.3 Planning

4.3.1 Planning permission has been granted by the London Borough of Hillingdon under planning reference. 75111/APP/2020/1955.

4.4	**General Description and Current Site Use**
4.4.1	At the time of writing this report, the former BA building had been demolished. At present, the demolition had been completed which has created a large, flat open area of land with a stockpile of crushed concrete. The BA plot is surrounded by North Hyde Gardens to the south, the River Crane/Yeading Brook to the east, a railway to the north, and Addison Lee car garage to the west.
4.4.2	The building on the Vodafone plot has now been demolished. At the time of the Phase 2 investigation the plot comprised a single office building, with car park, generator with above ground fuel storage tank (AST) and bin store. The generator and AST were located in the northeast part of the Vodafone plot. The tank was situated within a building. The external areas comprised an asphalt surfaced car park with paving and minor areas of planted vegetation along the site's boundary. The eastern part of the Vodafone plot slopes down to the River Crane/Yeading Brook and is covered with dense vegetation. In addition, the Parkway flyover is located east of the river. The Vodafone plot is surrounded by North Hyde Gardens to the north, a vehicle maintenance yard to the east, the Grand Union Canal and tow path to the south.
4.5	**History**
4.5.1	The earliest available map from 1865 shows the site as mostly vacant with a river running north to south along the eastern part of the site. This map also shows a railway and creosoting works in the northeast corner. Excavations and ground workings were noted from 1910. By 1932, the creosoting works had extended onto the site and a building was shown in the centre. The creosoting works were no longer shown by 1973 and a power station with chimney was shown in the western part of the site by 1983. By 2002, the power station was no longer shown and the British Airways building were shown. The building in the Vodafone plot was first shown by 2010. A review of planning applications indicate that no environmentally significant conditions were attached to the application to redevelop the site in 1998.
4.5.2	The surrounding area has supported various industrial (potentially contaminative) land uses, including factories, brick fields, mills, railway, electricity substation, creosoting works, and rubber works.
4.5.3	Historical landfilling has been identified on site and east of the River Crane/Yeading Brook since 1936 and records indicate the landfill accepted commercial waste. In addition, the British Geological Survey (BGS) artificial ground mapping covers the entire site.
4.6	**Geology**
4.6.1	From a review of BGS mapping (255, 256, 269, and 270), the geology of the subject site is reported to comprise of the Lynch Hill Gravel underlain by the London Clay Formation. The mapping also shows Artificial Ground, Langley Silt and Alluvium within 50m of the site. The Alluvium runs in the location of the river with deposits shown to be absent either side of the river. This is likely to be due to the slope on either bank. The Langley Silt may encroach onto the southern part of the site.
4.6.2	The surrounding area is known for being historically mined to extract the gravel. As such, there are many landfills and reservoirs in this area. It is therefore possible that the gravel deposits were largely extracted which allowed the landfilling to occur.

4.6.3 The ground conditions encountered during the earlier investigation at the site are referenced in Table 2 below.

Table 2. Ground conditions

Depth From (min/max) (m)	Depth To (min/max) (m)	Soil Type	Description
0.0	0.1 / 0.05	Concrete / Tarmacadam	Concrete / Tarmacadam hardstanding. MADE GROUND
0.05 / 0.1	1.5 / 5.8	Made Ground	Variable Made Ground comprising soft to firm, dark brown, gravelly clay. Gravel is brick, suspected slag, clinker, timber fragment, concrete and mixed lithologies. MADE GROUND
1.5 / 5.8	5.7 / 10.2	Gravel	Yellowish orange brown sandy GRAVEL. Gravel is sub-rounded to well-rounded fine to coarse mixed lithologies. LYNCH HILL GRAVEL.
5.7 / 10.2	Unproven	Clay	Firm to stiff silty CLAY. LONDON CLAY FORMATION.

4.6.4 The boreholes drilled on site (BA and Vodafone) encountered hard standing over Made Ground (cohesive and granular lenses) to a maximum depth of 5.8m bgl over Lynch Hill Gravels (cohesive and granular lenses) to 10.2m bgl over the London Clay Formation to a maximum drilled depth of 35.0m bgl.

4.6.5 The Made Ground has been found to vary significantly across the site. The desk study has indicated that the site was historically a landfill with industrial and commercial wastes being placed up to circa 1936. It is considered likely that the landfilling occurred as a result of gravel abstraction which was common place in the surrounding area. Furthermore, buried obstructions led to refusals at shallow depths.

4.7 Hydrogeology

4.7.1 The Lynch Hill Gravel is classified as a Principal Aquifer of high permeability and the London Clay Formation is classified as Unproductive Stratum. The previous investigation identified groundwater levels between 1.50m bgl and 4.90m bgl within the Made Ground, 6.00m bgl; and 6.50m bgl in the Lynch Hill Gravel and identified the direction of flow was generally towards the Yeading Brook/River Crane. Groundwater was struck at depth >6.00m bgl in the London Clay Formation in discrete pockets often coinciding with claystone bands.

4.7.2 The site is not situated within a Groundwater Source Protection Zone (SPZ).

4.7.3 There is one licensed groundwater abstraction within 1km of the subject site. This is located approximately 530m southeast of the site for evaporative cooling by Virtus Hayes Limited.

4.7.4	The concentrations of Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) identified within the groundwater during the Phase 2 investigation exceeded the Environmental Quality Standard (EQS), which was used to assess the risks to the River Crane/Yeading Brook (considered the most sensitive Controlled Water assessment). However, a Detailed Quantitative Risk Assessment (DQRA) was subsequently undertaken using the Remedial Targets Methodology which has shown that the site does not pose any significant risks to Controlled Waters (River Crane). As such, following the site investigations and DQRA undertaken to date it is considered unlikely that the contamination identified in site soils or groundwater would warrant remediation. Also, due to the presence of high levels of Ammonia already in the River Crane, it is unlikely that any remediation carried out on the Bulls Bridge would result in a measurable benefit to the River Crane.
4.8	**Hydrology**
4.8.1	The River Crane/Yeading Brook runs southwards through the eastern part of the site. The Grand Union Canal is located 10m south of the site and runs eastwards. No surface water abstractions have been identified within 1km of the site.
4.8.2	There are three discharge consents within 250m of the site. These relate to records approximately 10m north for miscellaneous discharge to land, 85m south and 95m south of the site from trade discharges to the River Crane/Yeading Brook.
4.8.3	Despite the presence of the River Crane adjacent to the site, the DQRA concluded that the site does not pose any significant risks to Controlled Waters (River Crane). Also, due to the presence of high levels of Ammonia identified in the upstream sampling points of the River Crane, it is unlikely that any remediation carried out on the Bulls Bridge would result in a measurable benefit to the River Crane.
4.9	**Flooding**
4.9.1	According to the EA website, the site is located within a Flood Zone 2 and 3 and has a moderate risk of flooding from rivers and the sea. In addition, the Risk of Flooding from Rivers and the Sea (RoFRaS) rating for the site is high. The impacts of flooding have been assessed in a separate Flood Risk Assessment, which should be reviewed for full details and information on flood risk.
4.10	**Regulatory Enquiries**
4.10.1	The Local Authority has not been contacted by Paragon at this time. However, it is considered unlikely that the site is currently designated as contaminated land under the provisions of the EPA 1990 Part 2A. No planning application has been lodged at this time, however, it is intended that this report be submitted in support of a planning application for the site.
4.10.2	The Environment Agency has not been contacted by Paragon as part of this assessment at this stage.
4.11	**Environmental Database Information**
4.11.1	No Areas of Outstanding Natural Beauty, Environmentally Sensitive Areas, Sites of Special Scientific Interest or Special Protection Areas have been identified within a 1km radius of the site.

4.12	**Ground Stability Hazards**
4.12.1	Records indicate that the area in general has a moderate risk of subsidence hazards as a result of shrinking/swelling of underlying clay.
4.12.2	The site is not located in a coal affected area.
4.13	**Unexploded Ordnance (UXO)**
4.13.1	A specialist assessment was undertaken by Brimstone Site Investigation Limited and comprised a Stage 2 Detailed UXO Risk Assessment (Dated: 3 July 2019, Ref: DRA-19-1105) to identify constraints at the site.
4.13.2	The report concluded there was a low to moderate risk from UXO and recommended mitigation measures. The risk mitigation measures included UXO safety awareness briefings, onsite supervision during excavations in the southern part of the site and a magnetometer probe survey if piling is to be implemented. This would need to be considered by future contractors who may be completing intrusive works at the site under their The Construction (Design and Management) Regulations 2015 (CDM) obligations.
4.14	**Radon**
4.14.1	The site is not located within a radon affected area. Less than 1% of homes are above the radon Action levels, as such, no radon protection measures are considered necessary.
4.15	**Constraints**
4.15.1	In addition to UXO, there are several constraints at the site that would need to be considered by a contractor. Notably the Crane Valley Sewer has been identified onsite and runs northeast/southwest through Vodafone, British Airways and part of Conway's Maintenance Yard. An inspection cover was opened within the Vodafone plot which identified a deep inspection chamber with multiple levels and water level at around 10m below ground level. We understand the client is commissioning a survey of the sewer under separate cover, however, this has not been received at this juncture.
4.15.2	Several concrete obstructions are reported beneath the hardstanding.
4.15.3	The results of environmental testing have identified asbestos fibres within shallow Made Ground across the site. A Contaminants of Concern (CoC) plan is presented as Figure 3 in Appendix 1. Tables showing the results are included in Appendix 2.
4.15.4	There were elevated concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) and Total Petroleum Hydrocarbons (TPH) within groundwater, which exceeded the Environmental Quality Standards (EQS) used to assess risks to the River Crane and Yeading Brook. A contaminants of Concern (CoC) plan is presented as figure 3. Tables showing the results are included in Appendix 2.
4.15.5	The results from gas and vapour monitoring have identified elevated concentrations of carbon dioxide, methane and naphthalene, via a comparison of groundwater results to the SoBRA groundwater vapour GAC (GACgwvap). Results are set out in Appendix 2.

4.15.6	Based on the risks identified in connection with the elevated contaminants of concern, a conceptual site model (CSM) was updated as part of the recent ground investigation. The CSM is reiterated below as this forms the basis of the remediation strategy, which is required to address the identified risks.

5.0 PRELIMINARY CONCEPTUAL SITE MODEL

5.1 Conceptual Site Model (CSM)

5.1.1 A CSM has been formulated for the site and is based on the results from the earlier investigations; it is presented in Table 3 below. The results on which the CSM is based are summarised on a Contaminants of Concern Plan presented as Figure 3 in Appendix 1. The results are also presented in Appendix 2.

5.1.2 The model is based upon the source-pathway-contaminant linkage concept set out in the Environmental Protection Act 1990 and accompanying statutory guidance. For a site to be designated under Part 2A of the EPA 1990 as contaminated land, there must be at least one plausible contaminant linkage and a significant risk to the receptor must exist as a result.

Table 3. Revised Conceptual Site Model

Receptor	Potential sources	Pathways	Risk	Justification
Human Heath				
Construction and maintenance workers / Users of the site	Organic and metal contamination	Direct contact, ingestion, and inhalation via outdoor soils or translocated soil and dust indoors.	L M	**Low to Moderate risk:** Ingestion, inhalation and dermal contact with contaminated soils in excavations or stockpiles cannot be discounted. Personal Protective Equipment (PPE) and Risk Assessments and Method Statements are required.
	Ground gas and vapours	Inhalation, Migration through granular and fractured soils into confined spaces.	L M	**Low to Moderate risk:** Inhalation of vapours from contaminated soils or groundwater below the site cannot be discounted due to the historical use of the site and the extent of previously untested areas.
Future site users	Organic and metal contamination in soils and groundwater	Direct contact, ingestion, and inhalation of outdoor soils or translocated soil and dust indoors.	L M	**Low to Moderate risk:** Inhalation of vapours from contaminated soils or groundwater below the site and contact with Made Ground in areas of soft landscaping may be possible.
	Ground gas and vapour	Inhalation, migration through granular and fractured soils into confined spaces.	L M	**Low to Moderate risk:** Inhalation of vapours from contaminated soils or groundwater below the site cannot be discounted.
Offsite Residents (250m southwest)	Organic and metal contamination in soils, groundwater and gas	Direct contact, ingestion, and inhalation of outdoor soils or translocated soil and dust indoors.	L	**Low risk:** Residents 300m southwest are unlikely to be at risk form contaminants arising from the site as they will be cut off by the Grand Union canal. The likelihood for migration to properties a similar distance to the northwest is minimal given the considerable distance to the properties and several other areas of industrial land in between.

5.1.3

Table 3. Revised Conceptual Site Model. (Continued)

Receptor	Potential sources	Pathways	Risk	Justification
Property				
Site structures and services	TPH in site soils	Direct contact between soil and structures or services.	L M	**Low to Moderate risk:** Direct contact of building materials including foundations and buried services with contaminated soils and groundwater is low to moderate based on laboratory testing.
	Ground gas and vapour	Migration through granular and fractured soils into confined spaces.	M	**Moderate risk:** The results of the investigation suggest that there is the potential for migration of gases and vapour through soil pore space and to the surface from underlying Made Ground and historical ground workings cannot be discounted.
Plants /Landscaping	Metals and organic contamination in soils	Root contact and uptake	L	**Low risk:** The results of the soil analysis have been compared to BS3882 and the risk to existing plants is low. However, a capping system is likely to be required due to the presence of asbestos within the shallow Made Ground.
Adjacent Property				
Building fabric of adjacent properties	Metals and organic contamination in soils	Soil leaching and migration and translocation as dust of soil contamination.	L	**Low risk:** Direct contact of building materials including foundations and buried services with contaminated soils and groundwater is low based on the low level of contaminants identified near to off-site property in the wider estate.
Groundwater				
Principal Aquifer	Metals and organic contamination in soils	Soil leaching and migration of potential soil contamination to dissolved phase in groundwater	L	**Low risk:** The assessment from the DQRA has determined that the site does not pose a significant risk to Controlled Waters.
Surface Waters				
River Crane/Yeading Brook (onsite) Grand Union Canal (5m south)	Leachable metals and organic contamination	Soil leaching and migration into drains and sewers which discharge into the ditch.	L	**Low risk:** The assessment from the DQRA has determined that the site does not pose a significant risk to Controlled Waters.

6.0 REMEDIATION OPTION APPRAISAL

6.1 Introduction

6.1.1 At this stage, the proposed development plans indicate the BA plot is to be redeveloped as a data centre and MV Energy Centre for a commercial end use and the Vodafone plot is to be developed into a substation. On this basis, the laboratory results from the earlier investigation were compared against the GAC for a commercial land use. This section evaluates the mitigation measures required to address risks to potential receptors at the site from elevated chemical contamination. Potential receptors have been identified, within the CSM presented in Table 3, with reference to available environmental guidance, whereby all receptors (humans, Controlled Waters, buildings etc) have been considered.

6.1.2 In line with Stage 3 of Land contamination: risk management (2020), the following considerations must be made when appraising the options for remediation. Remediation must:

- Be practical, effective and durable;
- Be compatible with other aspects of work such as redevelopment;
- Be achievable, sustainable and able to deal with uncertainty;
- Be verifiable by testing, measuring, monitoring or other recording methods; and
- Consider potential nuisance and disruption to local residents.

6.1.3 The remediation works must:

- Unacceptable risks have been satisfactorily mitigated; and
- The remedial works do not cause harm to human health or the environment.

6.2 Risks to Human Health from Soil Contaminants

<u>Asbestos in Made Ground</u>

6.2.1 The Made Ground was found to contain asbestos fibres in seven of the twenty-two Made Ground samples. The site is built on a historical creosote works and a landfill and the widespread asbestos may to be a result of infilling at the site. Whilst the site is currently surfaced with hardstanding, the risks to site users are mitigated. However, during development, the risk increases as this encapsulating layer is removed and new pathways are created.

6.2.2 Construction workers are likely to be at risk of exposure to asbestos, via inhalation pathways, as they would come into direct contact with soils during groundworks and excavations. It is anticipated that areas of Made Ground may be removed during groundworks and excavation of foundations as part of the construction process.

6.2.3	In order to entirely remove the risk of encountering asbestos fibres on site, the Made Ground source would need removal. However, this is impractical given the depth of Made Ground that exists below the site and the depth to which asbestos impacts have been found to c. 1.50m bgl. Removing impacted material to this depth would entail significant earthworks that would significantly disturb the ground and potentially increase the risks to site works versus leaving the materials in situ. Asbestos fibres are more prone to release in dry and disturbed conditions. Furthermore, by removing the asbestos impacted Made Ground, which would be unsuitable for re-use anywhere on site, the only option would be to dispose the arisings at a landfill facility off-site.
6.2.4	The cost associated with dig and dump would be uneconomical (higher rates of landfill tax would apply to such impacted material) and would also mean having to import backfill material to make up the deficit as the site is generally level and no significant changes in levels are required as part of the development proposals. This is a highly unsustainable process. Significantly with dig and dump, there is a risk of exposure to off-site receptors during the transportation of impacted materials off the site. Whilst damping down exercises and covering of waste haulage vehicles is good practice to minimise these risks, the most appropriate solution would be to leave the majority of material in situ (where possible). This presents a more sustainable option.
6.2.5	Therefore, based on the foregoing the most pragmatic approach to dealing with risks to site workers is to: • Employ the use of Personal Protective Equipment (PPE) and provide suitable welfare and decontamination units; • Have appropriate Risk Assessments and Method Statements (RAMS) put in places to highlight safe systems of work on site; • Plan works in line with the Control of Asbestos Regulations 2012: Asbestos in Soil (CAR-SOIL); • A misting strategy could be adopted at the site. By damping down stockpiles / arisings and misting at the site boundary to mitigate risks when impacted arisings are generated from the excavation of foundations and subsurface structural elements. Careful control of materials will be required and this is discussed further in Section 7.2. • Asbestos monitoring could be across the site to assess risks to site workers during ground works. Risks to off-site users would also require consideration during site works when impacted Made Ground is more likely to be disturbed, which is discussed further in Section 7.2.
6.2.6	In relation to the risks to future site users, based on the extensive covering of hard standing that is proposed the risks are anticipated to be minimal. Again, due to reasons set out above, encapsulation of the Made Ground below hard standing is a much more viable solution versus removal of the impacted Made Ground on site. Forming hard standing across the site is also compatible with the development proposals.
6.2.7	However, the development proposals do allow for discrete / nominal areas of soft landscaping and asbestos containing soils are not to be retained onsite in such areas where direct exposure pathways may remain. Therefore, as these areas are small it may be feasible to remove small areas and thicknesses of Made Ground. However, given the commercial nature of the site where the exposure frequency to site users is minimised, it is envisaged that the use of capping layers to add a clean break layer between Made Ground and the above ground receptor is acceptable. The nature of the capping layer and verification requirements are set out in Section 7.6.

	Hydrocarbons in Made Ground and Natural Soils
6.2.8	Two samples of Made Ground at BH07 at 2.55mbgl – 3.00mbgl and BH02 at 1.5mbgl were observed as having hydrocarbon concentrations above the limits of detection. These areas of contamination were attributed to the former use of the site as a creosote works based upon the historical site layout, observations in logs and the nature of the contaminants observed (naphthalene and so on).
6.2.9	During drilling, visual signs of contamination were noted within the natural soil and samples were submitted from BH03 at 3.8mbgl, BH07 at 5.8mbgl – 6.0mbgl and BH08 at 5.5mbgl – 6.0mbgl to establish the nature of contamination. The impacts were linked to the historical development of the site.
6.2.10	Based on the depth that contamination has been identified in the natural soils, i.e. >1.0m bgl, this is unlikely to impact upon site users via direct exposure, ingestion or inhalation of windblown dusts. Vapour inhalation pathways, possible from hydrocarbon contaminants, are considered separately below.
6.2.11	Risks to site workers by exposure to impacted arisings that may be generated from depth during the excavation of foundations can be controlled by means PPE and so on as set out above in Section 6.2.5. There will be residual risks to other receptors, such as Controlled Waters, from contamination present at depth. However, these risks are considered separately below.
6.3	**Risks to Human Health from Dissolved Phase Contaminants**
6.3.1	The risk from vapours has been considered based upon concentrations of hydrocarbons encountered in groundwater samples. These contaminants have the potential to volatilise and emit to outside air or ingress to indoor air space through cracks / entry points of the building. The measured concentrations of hydrocarbons in groundwater were compared with the SoBRA groundwater vapour GAC derived to assess the potential risk to human health from vapours generated from groundwater contaminants, based on a commercial end use. Based on assumptions relating to this assessment technique and the identification of possible free phase Non-Aqueous Phase Liquid (NAPL) in BH08, a conservative assessment of vapour risk has been made in the Ground Investigation report.
6.3.2	Owing to the depth of the hydrocarbon contamination identified, and for the reasons set out above, excavation and removal of hydrocarbon impacted soils is not considered to be a viable remediation option for these impacted soils. Extraction of soils for ex-situ treatment is also unlikely to be viable given the depth at which they have been encountered as this will involve significant disturbance of the asbestos contaminants Made Ground above.
6.3.3	Therefore, it may be possible to consider in situ treatment of hydrocarbons via means of air sparging (to encourage volatilisation and break down of hydrocarbons) at the depths where the contamination has been identified or In Situ Chemical Oxidation (ISCO), which involves the direct injections of reactive chemical oxidants into the groundwater and soil in order to quickly eliminate contaminants within the subsurface. Injection of a slurry to stabilise such contamination could also be considered at depth.

6.3.4	However, these remediation techniques are expensive and can typically take a long period of time to execute based upon the requirement for a detailed understanding the ground conditions and contaminants and the completion of pilot tests and studies. These type of remediation techniques tend to benefit from economies of scales across large sites that are widely impacted by contaminants. As the impact areas are relatively small and the vapour assessment is conservative at this juncture, it seems more pragmatic to make allowance for a vapour resistant membrane to be incorporated into new structures on site.
6.3.5	The main risk driver to human health from hydrocarbons would be via inhalation of vapour. Therefore, a membrane would mitigate the potential for vapours to ingress into the building and impact site users. It is likely that a damp proof membrane would be incorporated into the design of the structure in any case. Therefore, the specification could straightforwardly be upgraded to a vapour resistant design, which would still offer a robust solution to the issue.
6.4	**Risks to Human Health from Ground Gas**
6.4.1	Made Ground and landfilled materials were identified at the site. Therefore, gas monitoring and a Gas Risk Assessment were completed as part of the earlier Ground Investigation, in general accordance with BS8485:2015+A1:2019. The risk assessment established that the site would be classified as Characteristic Situation (CS) 2. Carbon dioxide was identified at a worst case concentration of 10.5% by volume in air (v/v) and based on a calculation of the Gas Screening Values and an exceedance of an acceptable threshold of 5% v/v, the CS2 classification was determined. It should be noted that appreciable concentrations of methane were also identified in one location >2% v/v.
6.4.2	In order to mitigate the risks to site users and the property, a gas resistant membrane is considered as the most pragmatic mitigation measure to be employed at the site. Made Ground is ubiquitous across the site and so for the reasons set out above its removal is not pragmatic and wholly unsustainable. The main risk driver to human health from hydrocarbons would be via inhalation of gas and accumulation within the on-site structures. It is likely that a damp proof membrane would be incorporated into the design of the structure in any case. Therefore, the specification could straightforwardly be upgraded to a gas resistant (and vapour resistant) design, which would offer a robust solution to the issue.
6.4.3	The Phase 1 investigation identified that the property is not located within a Radon Affected Area and as such, radon gas protection is not considered to be required.
6.4.4	It is considered that the risks to site workers, from the inhalation of gas and vapours that may be encountered during groundworks, can be mitigated by employing the use of PPE.
6.5	**Risks to Controlled Waters from Leachate and Groundwater**
6.5.1	The Phase 2 investigation identified contamination in site soils and groundwater, which would potentially pose a risk to controlled waters (River Crane) in the site's vicinity. As such, DQRA was undertaken.

6.5.2	The results of the DQRA determined that it is unlikely that the contamination identified in site soils or groundwater would warrant remediation. Monitoring of surface water in the River Crane has indicated that it is generally free of contamination, with the exception of Ammonia. This was found to be present upstream and downstream of the site, with the concentrations dropping slightly from upstream to downstream. This may indicate that the site is not having a tangible effect on the river. Due to the presence of high levels of Ammonia already in the River Crane, it is unlikely that any remediation carried out on the Bulls Bridge site would result in a measurable benefit to the River Crane. Based on the above, the report concluded that the site does not pose any significant risks to controlled waters (River Crane).
6.6	**Property and Infrastructure**
6.6.1	Plant growth can be affected due to the presence of phytotoxic contaminants including copper and zinc. These contaminants were identified at low levels within the Made Ground and as such, plant growth onsite is unlikely to be affected. The recommendations made above for the installation of a capping layer with create a suitable growth medium for plants and the details of the topsoil specification are set out in Section 7.6.
6.6.2	Sulphate testing was undertaken to assess the risks from aggressive ground on buried concrete. Recommendations are provided below for the concrete specification.
6.6.3	From a preliminary risk assessment of the results to thresholds set in the UK Water Industry Research (2010) '*Guidance for the selection of water supply pipes to be used in brownfield sites*', it is likely that barrier water pipes will be required for drinking water supply pipework. This is based on the contaminant concentrations recorded (in particular BTEX and MTBE, TPH C10 – C16 and TPH C16 – C40). Details are provided in Section 7.10.

7.0 REMEDIATION STRATEGY

7.1	**Introduction**
7.1.1	The following sections set out the outline approach to the remedial works required at the development site; this forms the remediation strategy for the site. The strategy should be read in conjunction with earlier phases of ground investigation and other reports as set out in Section 3.2.
7.1.2	It is intended that this strategy would be submitted alongside the planning application for the site and agreed in principle with the Local Authority Contaminated Land Officer (CLO). As the scheme progresses, the remediation strategy may be subject to revision as further information becomes available via a watching brief. Updates to the strategy should be completed in consultation with the CLO.
7.1.3	An outline Remediation Plan is presented as Figure 4 in Appendix 1.
7.2	**Site Clearance and Preparation**
7.2.1	It is understood that the existing covering of hardstanding across the site will be removed under a demolition contract. Therefore, the main contractor should be supplied with a copy of earlier environmental reports including this document to ensure that risks, particularly to site workers and off-site receptors, are mitigated.

7.2.2	As part of site clearance, the appointed contractor(s) will be responsible for the surplus arisings generated as part of their works unless a suitable re-use strategy for materials can be agreed. For example, the contractor may wish to consider the re-use of processed site won concrete from relic foundations and slabs under WRAP, which forms a quality protocol for the production and re-use of aggregate from inert waste. The contractor will be responsible for demonstrating that re-used materials are compliant for use on site, i.e. free from asbestos fibres.
7.2.3	As there may be a lag time between the demolition works and the construction phase, consideration could be given to the use of such site-won materials to form a blinding layer across the site. If the Made Ground (which has been found to comprise asbestos fibres) if left exposed and becomes dry and friable, then the risk of fibre release would increase. Therefore, a blinding layer would reduce this risk and may also reduce the potential for infiltration of residual contaminants in Made Ground to Controlled Waters.
7.2.4	In the interim period between demolition and construction boundary air monitoring for asbestos or misting could be considered to monitor risks (if any) to off-site receptors. These methods could also be adopted during the construction phase when Made Ground would again be subject to disturbance during the formation of foundations and subsurface structural elements. Recommendations are provided below in terms of controls to be put in place during the management of materials.
7.2.5	The appointed contractor(s) would be required to develop detailed method statements, and management plans with reference to currently available Health and Safety guidelines as set out by the Health and Safety Executive. These plans would define how works would be undertaken but as a minimum it is expected that the following would be considered: • Welfare and decontamination facilities, together with PPE; • Measures to mitigate the potential for generation of dust and nuisance odours; • Covering and / damping down of stockpiles; • Measures to avoid surface water run-off and pollution prevention controls to mitigate risks to the nearby surface water courses; • Regular cleaning of site roads and public highways; • Misting at the site boundary; • All waste haulage vehicles should be covered when leaving site to minimise the release of dust and fibres.
7.2.6	In addition to consideration of exposure to contamination, the main contractor(s) should also make allowance for watching briefs and on site monitoring for UXO on site when completing intrusive ground works. A UXO risk assessment was completed as part of the Phase 1 assessment and should be read in conjunction with this report. The site was zoned into low and moderate risk areas. Therefore, the main contractor(s) will need to ensure a strategy is in place for the areas of elevated risk. A watching brief for UXO should be maintained in lower risk areas.
7.2.7	As part of the remediation work, the main contractor(s) would also have obligations to maintain a watching brief for unforeseen contamination (see Section 7.3) and gather relevant data to be collated and submitted within a final verification report for the site.
7.2.8	The development area is largely free from structures. A generator with above ground storage tank previously situated within the Vodafone plot has now been removed and completion report is to be included in the verification report for the site.

7.3 Watching Brief

7.3.1 A watching brief should be maintained by the main contractor(s) at all times during groundworks.

7.3.2 Care must be taken during excavation works to inspect soils and breaking out and site preparation works progress to identify areas of unforeseen contamination. Such contamination would be identified by means of visual and olfactory appraisal by the main contractor(s) in the first instance. For example, this might mean:

- Soil or groundwater (if encountered) which appears by eye to have an unusual appearance, such as fibrous materials, Asbestos Containing Materials (ACMs), ash, oil or tar and any unusual discolouration.
- Soil or groundwater that presents an odour such as fuel, oil and chemical / solvent type odours or unusual odours such as sweet or rotten egg odours.
- Soil or groundwater that, when encountered affects the wellbeing of groundworkers, for example reports of personnel feeling light headed, nausea, complaining of stinging eyes or nasal passages and blistering or other forms of skin irritation.

7.3.3 Should areas of unexpected contamination be encountered, an environmental consultant / the CLO will be informed and the risk associated with the contamination assessed. To address such areas of concern the following methodology is recommended:

1. Stop works in the area immediately, note the location and cordon off the area if safe to do so.
2. Notify a suitably qualified environmental consultant who will attend site (if not already present) within a reasonable timeframe to sample the identified area.
3. Notify statutory regulators if required.
4. In order to allow works to progress, an environmental consultant will supervise the excavation of contaminated material, which should be placed in a dedicated bunded area and covered to prevent rainwater infiltration from spreading the contamination.
5. Excavations should be progressed outwards from the obviously impacted (discoloured / odorous) material until no further evidence of impact is observed. Soil samples will be obtained by a suitably qualified environmental consultant from both the excavated material and the soils in the sides and base of the excavation to demonstrate that the full area of contamination has been excavated. If appropriate, in-situ testing can be undertaken for verification purposes also, for example for asbestos fibres, which cannot be seen by eye. Soil sampling of asbestos will subsequently be carried out using a Hand Auger to obtain a sample of the soil, in concentric circles around known areas of impact, which will be submitted for asbestos identification and quantification by an independently accredited soils testing laboratory.
6. Contamination testing will be scheduled that is commensurate with the visual / olfactory observations made about the possible type of contamination encountered at the time. However, as a minimum a suite of contamination (heavy metals, asbestos, TPHCWG, speciated PAH, pH, SOM, VOCs and SVOCs) will be completed on all samples.
7. Upon receipt of the chemical test results, the soils can be dealt with accordingly i.e. treatment, disposal or re-use (subject to the wider Remediation Strategy and any materials management plan – see Section 7.5).

7.3.4	In areas where hotspot removal is completed, open excavations should be cordoned off until testing results are received and it is possible to backfill the area (if required). Imported materials will require provenance data certifying them as 'clean' and free from ACMs and asbestos fibres. Soils are to be compacted upon placement to achieve a suitable California Bearing Ratio (CBR) value for a formation level.
7.3.5	Records and testing certification will be maintained for inclusion into a verification report. The Main Contractor should provide their daily records / log books for the watching brief.
7.4	**Asbestos in Soil**
7.4.1	Based on the presence of asbestos fibres within the shallow soils onsite, it is likely that some degree of asbestos management will be required. The protection of workers from exposure to asbestos is regulated by the Control of Asbestos Regulations (HSE, 2012). As such, appropriate Risk Assessments and Method Statements should be put in place to ensure the risks are minimised. This should be not be limited to Personal Protective Equipment (PPE) and Respiratory Protective Equipment (RPE), segregation of stockpiles, dust suppression by damping down stockpiles, and / or covering stockpiles with sheeting.
7.4.2	The appointed contractor(s) would be responsible for producing detailed method statements and a management plans based upon the presence of asbestos. They would also be responsible for notifying the Health and Safety Executive and obtaining relevant licenses to undertake any notifiable works.
7.5	**Waste Management**
7.5.1	At this stage, no Waste Acceptance Criteria (WAC) tests have been carried out. A preliminary Waste Assessment was completed in 2019 and is presented in Appendix 3. This document should be provided to a waste receiver to confirm an acceptable end point for disposal of surplus materials. WAC testing may be required as part of the ongoing development and quantification analysis of asbestos may be required to assess a suitable end point of disposal for asbestos contaminated arisings.
7.5.2	The Hazardous Waste (England and Wales) Regulations 2005 requires that any waste having an asbestos (ACM) content greater than 0.1% by weight/weight be classified as hazardous waste. Waste with an asbestos content of less than 0.1% w/w can be classified as non-hazardous waste, unless there are other contaminants present, which would make the waste hazardous.
7.5.3	Based on a preliminary waste classification assessment completed in 2019 by Paragon, the tested soils onsite (Made Ground and Natural Soil) appear to be Non-Hazardous in nature. The laboratory certificates, waste classification outputs and drilling logs, provided in the appendices, should be provided to the waste receivers to confirm their ability to accept waste arisings from the site. It is the waste producer's (the main contractor(s)) responsibility to classify and appropriately manage waste under duty of care (Section 34 of the Environmental Protection Act 1990. Owing to the nature of arisings leaving the site, the main contractor(s) may need to put a materials management plan in place to monitor volumes of material leaving site together with the associated Duty of Care records, which should be maintained for inclusion into a final verification report.

7.6 Contamination and Remediation

7.6.1 The extensive covering of hardstanding across the site is anticipated to mitigate risks to site users and is likely to be engineered across the site as part of the formation of the building footprints, pavements and roadways.

7.6.2 Where landscaped areas are proposed, a capping layer will be required to prevent contact with underlying contaminants, which should be formed as per the specification in Table 4. The clean cover is considered sufficient to supress dust generation and restrict dermal contact and ingestion of contaminated soils, and the inhalation or contaminated dusts or asbestos fibres.

Table 4. Composition of Capping Layer

Layer	Minimum Thickness
Topsoil	150
Subsoil	450
Geotextile	Terram 1,000 or similar

7.6.3 The topsoil and subsoil are to meet the requirements of BS3882, Specification for Topsoil. The supplier should provide a test certificate prior to purchase. It is then recommended to test the soils once they arrive onsite to ensure they meet the requirements for a commercial land use based on S4ULs and C4SLs. The importation criteria are included in Appendix 4.

7.6.4 Verification of the thickness of clean capping installed (via photographs and measurements) is required by a third-party together with testing of the imported materials once they reach site. Prior to bringing materials to the site, the contactor would provide provenance data to confirm the suitability of material to be brought to site. This information would be detailed within the verification report.

7.6.5 The chemical quality of imported soils/ site won materials used in soft landscaped areas should be verified laboratory chemical analysis to be completed by an MCERTS and UKAS accredited laboratory. Estimated frequencies of testing for soft-landscaped areas are as follows:

- 1 sample per 100m^3 of topsoil and
- 1 sample per 250m^3 subsoil.

7.7 Gas Protection Measures

7.7.1 Based on the proposed development, which is understood to be a data centre and an HVO energy centre and a substation, the site use is considered to be less sensitive than if the site was used for residential purposes. The monitoring undertaken to date has analysed boreholes from across the development area and within the wider site boundary. The results have shown the Characteristic Situation (as outlined in BS8485:2015+A1:2019) to be CS2 within the BA plot and CS2 within the Vodafone plot.

7.7.2	Based on an industrial building type (Type D) and a conservative CS score of 2, the total number of points required in line with BS8485:2015+A1:2019 would be 1.5. A potential measure to meet this score could involve installing a gas membrane that meets the following criteria: 1. Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method); 2. Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; 3. Sufficiently strong to withstand in-service stresses e.g. settlement if placed below a floor slab); 4. Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); 5. Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and 6. Verified in accordance with CIRIA C735.
7.7.3	In addition, in line with the results from the vapour risk assessment, although the sensitivity analysis reported by SoBRA in producing the vapour GAC identified the vapour GAC may be overestimating the risk, a conservative approach would be to allow for a gas membrane suitable to mitigate against vapours. As a standard gas membrane is considered to be a requirement for CS2, it is not considered onerous to upgrade this to a gas (methane and carbon dioxide) and vapour resistant membrane.
7.7.4	Based on the results of the gas and vapour risk assessments, it is possible additional monitoring in the footprint of the new building could reduce the risk rating. However, based on the foregoing, it is anticipated that a hydrocarbon resistant (for TPH and PAHs including naphthalene) would be required. The membrane should also be gas resistant (methane and carbon dioxide).
7.7.5	The final specification for the membrane and the design of its incorporation into the buildings would need to be completed by a specialist. The installation of the membrane would require verification as set out in Section 7.12.
7.7.6	A gas membrane would not be required in open sided buildings and is only required in enclosed buildings.
7.8	**Controlled Waters and Long Term Monitoring Plan**
7.8.1	Despite the results of the DQRA indicating the risk of site-derived contaminants impacting the river is low, based on the proximity of the River Crane to the site, ongoing monitoring should be undertaken during development to ensure that no adverse impacts to the river are caused during development.
7.8.2	Monitoring should involve sampling existing boreholes (if possible) or from new boreholes drilled on the eastern part of the site. The monitoring should also include sampling of surface water from the river at upstream, adjacent and downstream points.
7.8.3	The monitoring should be undertaken pre-development, during development and post-development. Contaminants to be analysed include metals, PAH, TPH CWG and BTEX, phenols, and ammonia/ammoniacal nitrogen based on the testing completed to date based on the historical use of the site and contaminants previously identified. In addition, parameters including pH, EC, Salinity, NO3, NO2, Mn2+ and Mn3+ will be recorded. The monitoring plan is presented below.

Table 5. Long Term Monitoring Plan

Time	Monitoring Requirements
Pre-Development	1 baseline monitoring to be completed visit prior to breaking ground.
During Development	2 visits during piling and groundworks spaced 2 months apart.
Post-Development	1 visit to be completed 1 month after completion.

7.8.4 The monitoring will be undertaken using low flow methods using a peristaltic pump and will include continuous monitoring of in-situ groundwater parameters (conductivity, temperature, dissolved oxygen, redox and pH). The in-situ parameters will be recorded using a fully calibrated AquaTROLL 500 (or similar) multiparameter probe connected via a flow-through cell.

7.8.5 Four boreholes dedicated to long term monitoring have been installed along the edge of the site close to the River Crane. Their locations have been chosen to ensure they are not affected by the construction works on site. The borehole locations are shown in Figure 3.

7.8.6 Should a deterioration in groundwater quality be detected in the Lynch Hills Gravel that may be related to the piling works, the piling operations will be stopped and the cause of the deterioration investigated. This would be through additional groundwater monitoring and cross-checking with recent piling records.

7.9 Piling Works Risk Assessment and Decommissioning of Boreholes

7.9.1 There may be an increased risk to Controlled Waters from the piling required for the scheme from vertical migration of groundwater from the Made Ground to the underlying aquifers mobilised during piling. This is of particular importance if the final loading of the building increases significantly than the loads used in this investigation, as this would mean deeper piles would be required which may penetrate the London Clay and terminate in the underlying Chalk which is classified as a Principal Aquifer and drinking water resource.

7.9.2 During the investigation, elevated concentrations of contaminants have been recorded, which have the potential to impact Controlled Waters. As such a Piling Works Risk Assessment (PWRA) may be required to demonstrate that contamination will not be mobilised during piling from shallow horizons of Made Ground to the more sensitive horizons below.

7.9.3	The PWRA should be completed in accordance with the Environment Agency document: Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. Ref: NC/99/73. May 2001. The assessment should consider the six pollution scenarios identified for piling operations by the Environment Agency in relation to the site specific ground conditions encountered and the final piling solution to be adopted. At this juncture Continuous Flight Auger (CFA) or sleeved bored piles have been considered by the geotechnical assessment. The pollution scenarios are as follows: 1. Creation of preferential pathways through a low permeability layer (aquitard) to allow potential contamination to an underlying aquifer; 2. Creation of preferential pathways through a low permeability surface layer to allow either upward migration of landfill gas, soil gas or contaminant vapours to the surface or infiltration of surface water thereby causing leachates in contaminated soils; 3. Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface; 4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration); 5. The driving of solid contaminants down into an aquifer during pile driving; and 6. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.
7.9.4	Upon completion of monitoring, the onsite boreholes will need to be decommissioned. Redundant boreholes would be decommissioned by the contractor(s) in general accordance with the Environment Agency Document 'Good Practice on Decommissioning Redundant Boreholes and Wells'.
7.10	**Buried Services**
7.10.1	In accordance with the UK Water Research Guidance (2010), it is recommended that barrier water pipes are used based on the contaminant concentrations recorded and subject to agreement by the water supply company. Barrier pipe typically incorporates an impermeable aluminium barrier layer wrapped onto a central core of Medium-Density Polyethylene (MDPE), which makes it resistant to permeation of contaminants.
7.10.2	Based on the composition of surrounding Made Ground it would be anticipated that new services should be placed within 'clean' service corridors to be constructed as part of the proposed development. Service corridors should be excavated and a marker layer (teram or similar) placed at the base and sides of the trench before backfilling with material such as clean, certified pea shingle. Any testing of imported aggregate materials should be completed at the frequency discussed in Section 7.2.2.

7.11	**Buried Concrete**
7.11.1	Based on the results of the pH and sulphate testing carried out on samples from the Made Ground and Lynch Hill Gravel Member, the DS and ACEC classification for these strata is DS-2 and AC-2.
7.11.2	The DS and ACEC classification for the London Clay stratum is dependent on the level to which the soil is disturbed and subsequently oxidised. Unweathered London Clay Formation typically contains pyrite, which when oxidised causes an increase the availability of Total Potential Sulphate (TPS). This leads to an increase in sulphate ions which can reach the concrete and cause sulphate attack. For construction processes that avoid ground disturbance and subsequent oxidisation of the soil (such as precast or cast-in-situ piles) the DS and ACEC classification is DS-2 and AC-1s. For activities such as spread footings constructed in an excavation the classification is DS-4 and AC-3s.
7.12	**Verification Plan**
7.12.1	Based on the Stage 3 requirements of Land contamination: risk management (2020 revision of CLR11), the remediation strategy requires verification to demonstrate that the remediation has worked. The Verification Plan must make sure that: • Unacceptable risks have been satisfactorily mitigated; • The remedial works do not cause harm to human health or the environment; and • There is an accurate final record of the land quality.
7.12.2	The following strategy sets out the requirements of the main contractor(s) in terms of collating information during development and the responsibilities of an environmental consultant in reporting on the findings of third-party verification activities.
7.12.3	Periodic site audits would be required to ensure adequate site records and documentation are being maintained during demolition and construction works. There would need to be regular communication between the environmental consultant and the main contractor(s). The purpose of the verification plan is to provide a final Verification Report, which provides an accurate record of the final land quality as per the requirements of statutory guidance. The report would seek to demonstrate that remediation is successful in addressing the risks raised by the Conceptual Site Model.

7.12.4	The purpose of the verification plan is to obtain essential 'lines of evidence' that remediation has been satisfactorily completed and will involve: • Agreement by regulators to the proposed Remediation Strategy and details of associated permits or exemptions required for the remediation works (if any); • Details and findings any health and safety controls implemented on site with regard to asbestos management (eg: dampening down); • Records from the watching brief and outcomes of any areas of unexpected contamination and the actions undertaken; • Plan showing location of any additional samples obtained for testing for delineation and management of materials; • Results of any additional chemical / Waste Acceptance Criteria (WAC) testing including details of laboratory quality assurance and accreditation; • Details of material (solid / liquid) disposed off-site including waste classification, details of the receiving site(s) and hauliers and copies of all Duty of Care records; • Details of any re-using of material including details of location and any re-use protocols; • Details of the above ground tank decommissioning and removal including all associated records from a tank specialist; • Records of the installation of the clean capping layers including a layout plan, demonstration of chemical compliance (via review of provenance data prior to importing material and subsequent chemical testing of material on-site), records of the thickness placed and the presence a demarcation layer (including photographs); • Quantities of materials imported to site and chemical testing results and information on the source of any imported material and plans showing where this material has been used; • Records of the ground gas and vapour protection measures installed at the site (including agreed specification, inspection records and photographs) and independent verification in accordance with CIRIA C735; • Records of the implementation of clean service corridors including demonstration of the chemical compliance of imported pea shingle, barrier pipe works specification (including copies of correspondence with local water service provider, pipework layout plans and site records / photographs; • Long term monitoring results; and • As Built information and concrete design specification.
7.12.5	On completion of the above, the verification report would be submitted to the Local Planning Authority for their approval. A copy of the report would need to be retained within the health and safety file for the scheme.
7.12.6	In the first instance, this Remediation Strategy should be submitted to the Local Planning Authority for their comments and approval.

1.0 APPENDIX 1: FIGURES

0 50 100 m

building & project consultants
paragon
Paragon Building Conultancy
65 Southwark Street
London
SE1 0HR
020 7125 0112
www.paragonbc.co.uk

Notes:

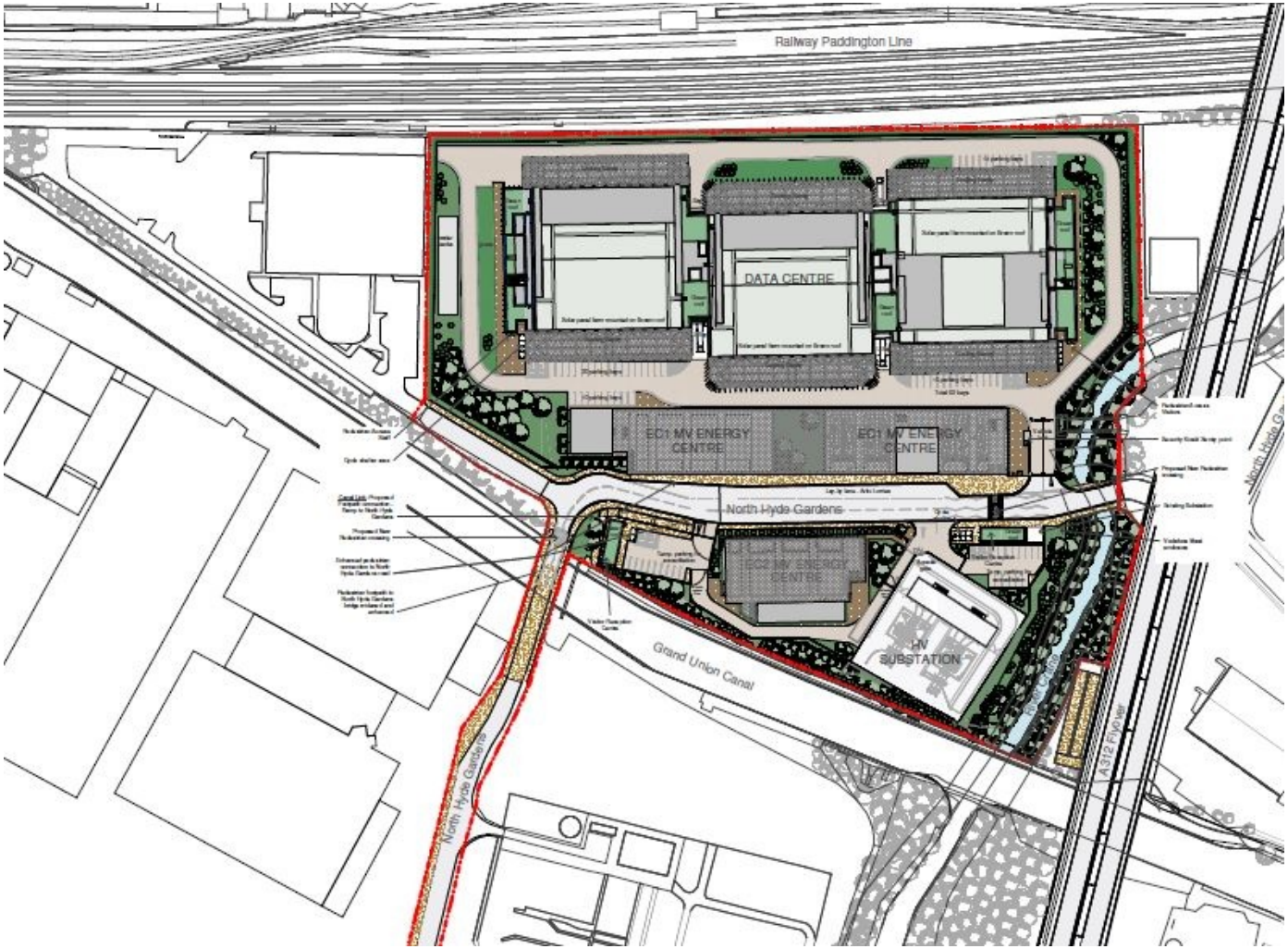
Basemap: Google 2019. Insert Map: Google 2019.

Site Location

Development Area

Rev	Description	Date

Project: Bulls Bridge, Hayes	Scale: 1:3000
	Drawn by: CB
	Approved By: CK
Title: Site Location Plan	Drawing Number: 1
	Date: 17/12/2020



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020 7125 0112
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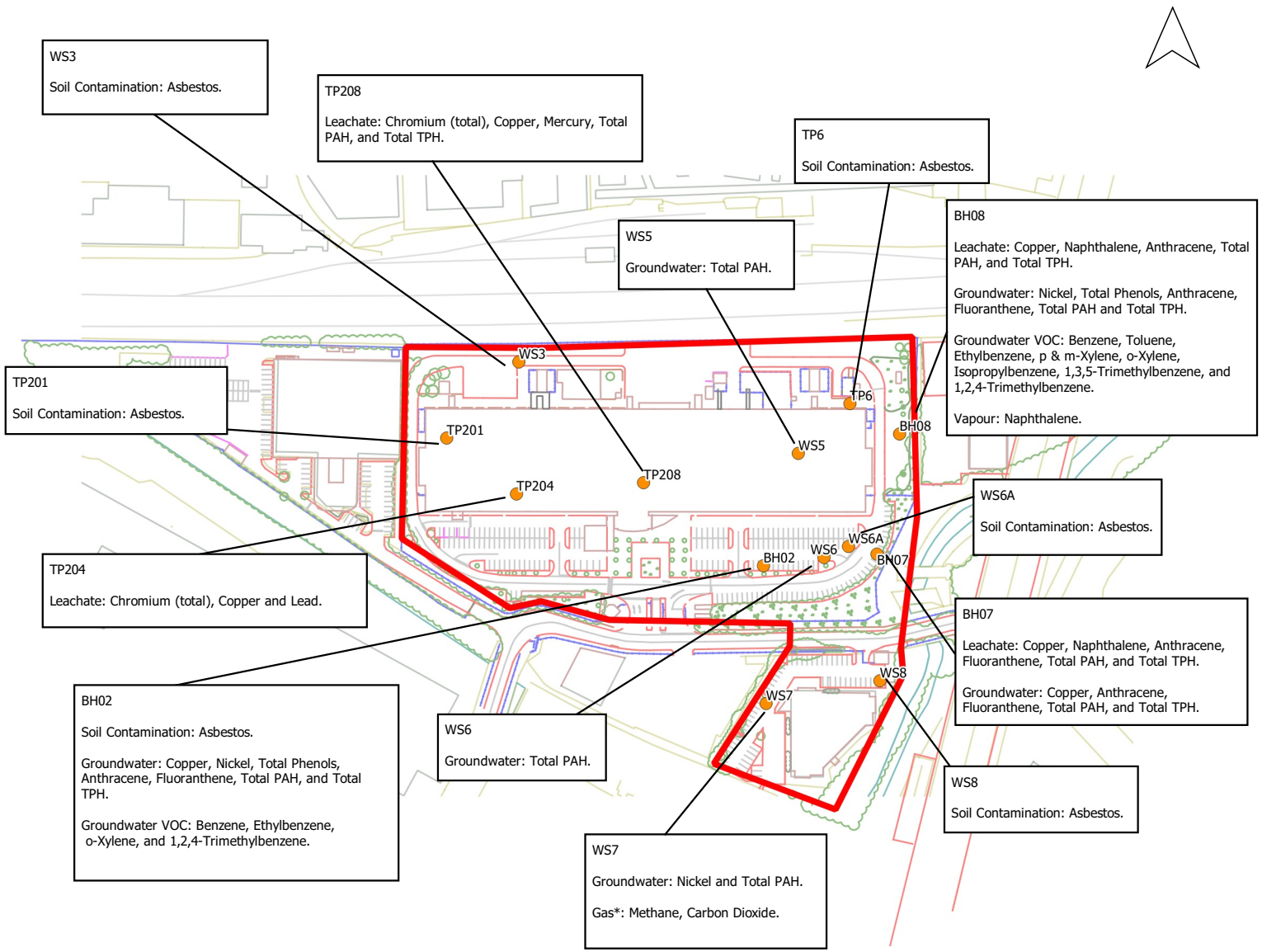
Notes:

Drawing based on Nicholas Webb Architects plc, Project Union A90 - External Works Site Plan, Aerial View. Ref: NWA-0471-SN-ZZ-DR-A-90-005. P01. Dated 27/03/20, amended 18/08/2021.

Development Plot

Rev	Description	Date

Project: Bulls Bridge, Hayes	Scale: Not to scale
	Drawn by: CB
	Approved By: CK
Title: Proposed Development Plan	Drawing Number: 2
	Date: 03/11/2021



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Notes:

Drawing based on the results from the Ground Engineering Ltd Utility Survey. Ref: 35406. Dated: 19/07/2019.

Boreholes where no elevated contamination was identified have not been presented.

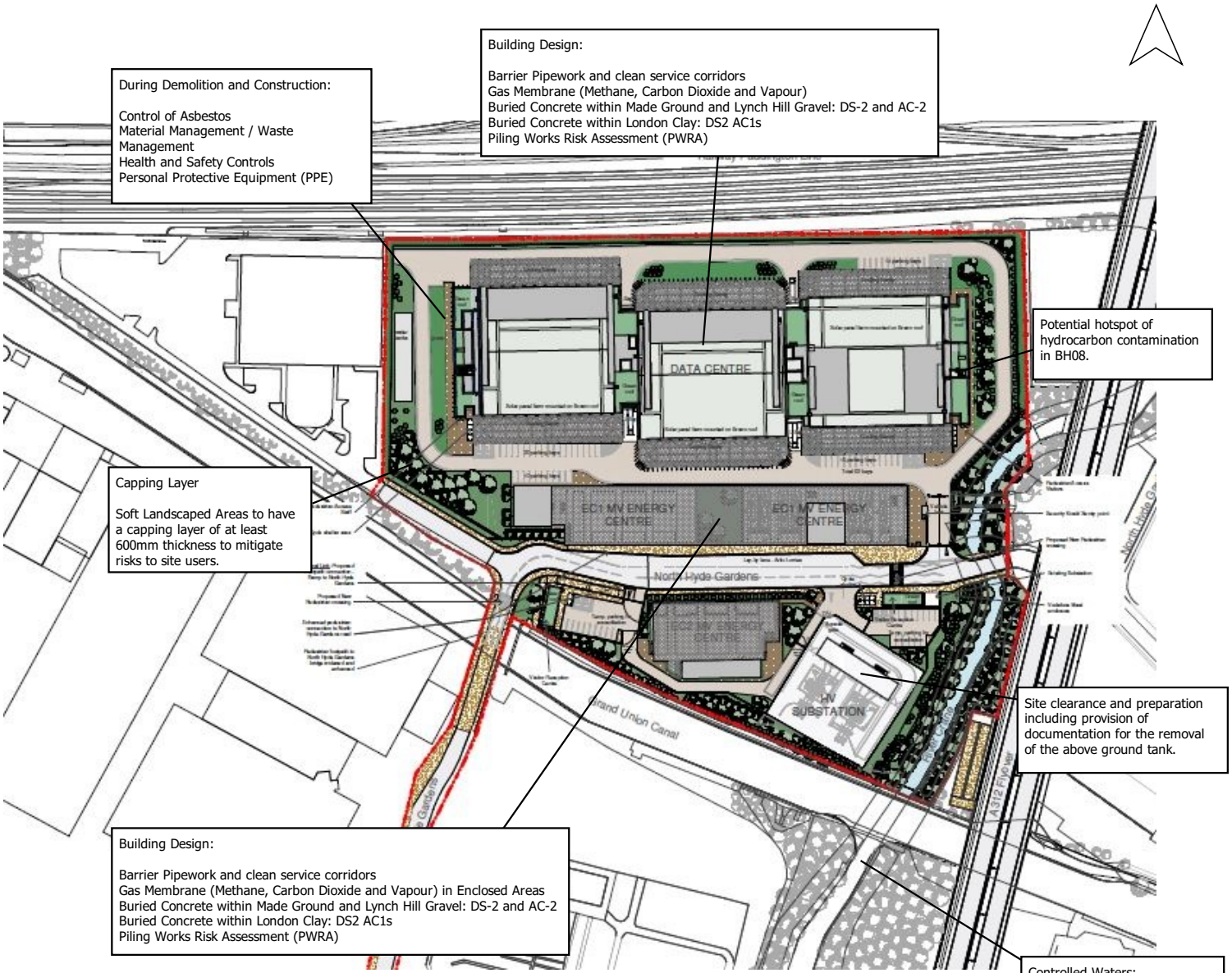
* The gas risk to the site is based on a Gas Screening Value (GSV) calculated based on the worst case which was identified in WS7.

Key

- Site boundary
- Intrusive locations with elevated contamination

Rev	Description	Date

Project: Bulls Bridge, Hayes	Scale: 1:3000
	Drawn by: CB
	Approved By: CK
Title: Contaminants of Concern Plan	Drawing Number: 3
	Date: 17/12/2020



During Demolition and Construction:

Control of Asbestos
Material Management / Waste Management
Health and Safety Controls
Personal Protective Equipment (PPE)

Building Design:

Barrier Pipework and clean service corridors
Gas Membrane (Methane, Carbon Dioxide and Vapour)
Buried Concrete within Made Ground and Lynch Hill Gravel: DS-2 and AC-2
Buried Concrete within London Clay: DS2 AC1s
Piling Works Risk Assessment (PWRA)

Potential hotspot of hydrocarbon contamination in BH08.

Capping Layer

Soft Landscaped Areas to have a capping layer of at least 600mm thickness to mitigate risks to site users.

Site clearance and preparation including provision of documentation for the removal of the above ground tank.

Building Design:

Barrier Pipework and clean service corridors
Gas Membrane (Methane, Carbon Dioxide and Vapour) in Enclosed Areas
Buried Concrete within Made Ground and Lynch Hill Gravel: DS-2 and AC-2
Buried Concrete within London Clay: DS2 AC1s
Piling Works Risk Assessment (PWRA)

Controlled Waters:

The DQRA determined that there are no remediation requirements but long term monitroing will be completed to check the quality of the river.

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Notes:

Drawing based on Nicholas Webb Architects plc, Project Union A90 - External Works Site Plan, Aerial View. Ref: NWA-0471-SN-ZZ-DR-A-90-005. P01. Dated 27/03/20, amended 18/08/2021.

Rev	Description	Date

Project: Bulls Bridge, Hayes	Scale: Not to Scale
	Drawn by: CB
	Approved By: CK
Title: Remediation Plan	Drawing Number: 4
	Date: 03/11/2021

2.0 APPENDIX 2: ELEVATED CONTAMINANTS

ELEVATED CONTAMINANTS

Analytical Test Results

The following results of the soil and groundwater analysis have been taken from the Paragon (2020) Phase 2 Ground Investigation Report, ref 20.00213 dated 6 March 2020, Rev B – Revised June 2020 which should be read in full for information on the sampling strategy, rationale, QA and accreditations. The laboratory certificates were included in this original report.

The soil results were compared to a screening value to determine whether contamination has occurred. Where possible, a statistical assessment was carried out based on the methodology set out in CIEH report 2008: Guidance on comparing Soil Contamination Data with a Critical Concentration. The statistical assessment involved calculating the upper confidence level (U95 value), which was compared with the mean of the dataset. The U95 is the level at which we would be 95% confident that the true mean is less than the screening value. Statistical analysis was undertaken on populations of 6 or more.

An assessment for outliers has also been undertaken, however these have not automatically been removed from the dataset. The CIEH (2008) guidance notes that outliers should be excluded from a dataset where they are the result of an error that can be identified and explained, or indicate that more than one soil population exists. If during the assessment, an outlier has been suspected, this has been presented and discussed separately.

A table showing the outcome of the statistical assessment on soil samples from the Made Ground is set out below.

No elevated contaminants, above the commercial GAC thresholds were encountered. However, positive identification of asbestos fibres was reported.

Chemical Analysis (Made Ground Soils).

Contaminant	Maximum Result (mg/kg)	Number of Samples	U95 (mg/kg)	Evidence Level (%)	GAC (mg/kg)	Exceedances
Asbestos	Chrysotile (Loose Fibres)	15	N/A	N/A	N/A	7* (WS3, WS6A, WS8, TP6, TP201 and BH02 between depths of 0.3mbgl and 1.5mbgl)
Arsenic	317	15	123.7	100	640	None
Cadmium	5.8	15	2.3	100	410	None
Chromium	143	15	52.1	100	8600	None
Copper	360	15	1.1	100	68000	None
Lead	843	15	184.3	100	2330	None
Mercury	2.2	15	434.8	100	58	None
Nickel	56	15	1.3	100	980	None
Selenium	< 1.0	15	30.6	100	12000	None
Zinc	285	15	1.7	100	730000	None
Hexavalent Chromium	< 1.2	15	208.0	100	49	None
Naphthalene	4.65	15	2.2	100	190	None
Acenaphthylene	1.1	15	0.5	100	83000	None
Acenaphthene	79	15	29.1	100	84000	None
Fluorene	62	15	23.0	100	63000	None
Phenanthrene	70	15	30.8	100	22000	None
Anthracene	83	15	30.9	100	520000	None
Fluoranthene	95	15	39.9	100	23000	None
Benzo(a)pyrene	11	15	2.2	100	76	None
Aliphatic >EC5 - EC6	< 0.001	15	< 0.001	100	3200	None
Aliphatic >EC6 - EC8	< 0.001	15	< 0.001	100	7800	None
Aliphatic >EC8 - EC10	< 0.001	15	1.3	100	2000	None
Aliphatic >EC10 - EC12	13	15	7.9	100	9700	None
Aliphatic >EC12 - EC16	250	15	140.2	100	59000	None
Aliphatic >EC16 - EC21	1500	15	765.6	100	1600000	None
Aliphatic >EC21 - EC35	754	15	332.1	100		None
Aromatic >EC5 - EC7	< 0.001	15	< 0.001	100	26000	None
Aromatic >EC7 - EC8	0.01	15	0.03	100	56000	None
Aromatic >EC8 - EC10	6	15	3.4	100	3500	None
Aromatic >EC10 - EC12	11	15	8.0	100	16000	None
Aromatic >EC12 - EC16	200	15	121.2	100	36000	None
Aromatic >EC16 - EC21	560	15	400.7	100	28000	None
Aromatic >EC21 - EC35	1584	15	181.6	100		None

* *Note to table: Whilst no GAC is available for asbestos, the seven samples where asbestos has been identified has been noted as above detectable concentrations.*

Analytical Test Results – Natural Soils

The results of the chemical analysis on the natural soil samples are presented below and similarly the results were compared to the GAC for a commercial use.

No exceedances, above acceptable thresholds for a commercial land use, were identified of the contaminants tested from natural soils.

Chemical Analysis (Natural Soils).

Contaminant	Maximum Result (mg/kg)	Number of Samples	GAC (mg/kg)	Exceedances
Asbestos	None	3	N/A	None
Arsenic	22.0	3	640	None
Cadmium	< 0.2	3	410	None
Chromium	30.0	3	8600	None
Copper	14.0	3	68000	None
Lead	14.0	3	2330	None
Mercury	< 0.3	3	58	None
Nickel	33.0	3	980	None
Selenium	< 1.0	3	12000	None
Zinc	43.0	3	730000	None
Hexavalent Chromium	< 1.2	3	49	None
Naphthalene	79.0	3	190	None
Acenaphthylene	3.4	3	83000	None
Acenaphthene	100.0	3	84000	None
Fluorene	270.0	3	63000	None
Phenanthrene	200.0	3	22000	None
Anthracene	76.0	3	520000	None
Fluoranthene	380	3	23000	None
Benzo(a)pyrene	11.0	3	76	None
Aliphatic >EC5 - EC6	< 0.001	3	3200	None
Aliphatic >EC6 - EC8	< 0.001	3	7800	None
Aliphatic >EC8 - EC10	< 0.001	3	2000	None
Aliphatic >EC10 - EC12	9.5	3	9700	None
Aliphatic >EC12 - EC16	41.0	3	59000	None
Aliphatic >EC16 - EC21	32.0	3	1600000	None
Aliphatic >EC21 - EC35	23.0	3	1600000	None
Aromatic >EC5 - EC7	< 0.001	3	26000	None
Aromatic >EC7 - EC8	< 0.001	3	56000	None
Aromatic >EC8 - EC10	< 0.001	3	3500	None
Aromatic >EC10 - EC12	110.0	3	16000	None
Aromatic >EC12 - EC16	930.0	3	36000	None
Aromatic >EC16 - EC21	1900.0	3	28000	None
Aromatic >EC21 - EC35	480.0	3	28000	None

Analytical Test Results – Leachate Testing

Leachate analysis was completed on the Made Ground and natural soil to assess the impact to Controlled Water from site derived contamination. The results were compared with Environmental Quality Standards (EQS) for freshwater where available, due to the presence of the River Crane/Yeading Brook adjacent to the BA plot.

The river was considered the most sensitive surface water receptor. No assessment against the Drinking Water Standards (DWS) has been completed as there are no sensitive potable abstractions within a 1km radius and the site is not within an SPZ.

Exceedances of the EQS were identified for heavy metals (chromium, copper, and lead), PAH (Naphthalene, Anthracene, and Fluoranthene) and Total TPH.

Chemical Analysis (Leachate).

Contaminant	Result Range (µg/l)	Number of Samples	EQS (µg/l)	Exceedances
Arsenic	<1.1 – 6.5	4	50.0	None
Beryllium	<0.2	4	15	None
Cadmium	<0.08	4	0.08	None
Chromium	0.8 – 18.0	4	4.7	2 (TP204 and TP208)
Copper	2.8 – 14.0	4	1.0	4 (TP204, TP208, BH07 and BH08)
Lead	<1.0 – 14.0	4	4.0	2 (TP204 and TP208)
Mercury	<0.5 – 1.0	4	0.07	1 (TP208)
Nickel	<0.3 – 1.8	4	4.0	None
Zinc	3.4 – 10.0	4	10.9	None
Free Cyanide	<10.0	4	1	None
Naphthalene	<0.01 – 4700.0	4	2.0	2 (BH07 and BH08)
Anthracene	<0.01 – 5.8	4	0.1	2 (BH07 and BH08)
Fluoranthene	0.75 – 4.8	4	0.1	3 (TP208, BH07 and BH08)
Benzo(a)pyrene	<0.01 – 0.01	4	0.02	None
Total PAH	<0.2 – 5000.0	4	< LOD	3 (TP208, BH07 and BH08)
Benzene	<1.0	4	10.0	None
Toluene	<1.0	4	74.0	None
TPH-CWG Aliphatic and Aromatic bands	<10.0 – 8700.0	4	10.0	3 (TP208, BH07 and BH08)

Analytical Test Results – Groundwater

The results from the groundwater analysis were compared with Tier 1 screening values, as for the soils. This has included Environmental Quality Standards (EQS) for freshwater, due to the presence of the River Crane/Yeading Brook adjacent to the BA plot, which would be considered the most sensitive surface water receptor. There is potential for dissolved phase contaminants in groundwater to migrate to the river if they are in continuity.

Chemical Analysis (Groundwater).

Contaminant	Result Range (µg/l)	Number of Samples	EQS (µg/l)	Exceedances
Arsenic	<5.0 – 21.0	6	50.0	None
Beryllium	<0.1	6	15	None
Cadmium	<0.02 – 0.03	6	0.08	None
Chromium	0.3 – 0.5	6	4.7	None
Copper	0.6 – 2.0	6	1.0	2 (BH02 and BH07)
Lead	0.3 – 0.7	6	4.0	None
Mercury	<0.05	6	0.07	None
Nickel	3.3 – 7.3	6	4.0	3 (WS7, BH02 and BH08)
Zinc	2.4 – 9.3	6	10.9	None
Free Cyanide	<10.0	6	1	None
Total Phenols	<10 – 280	6	7.7	2 (BH02 and BH08)
Naphthalene	<0.01 – 585	6	2.0	1 (BH08)
Anthracene	<0.01 – 0.79	6	0.1	3 (BH02, BH07 and BH08)
Fluoranthene	<0.01 – 0.9	6	0.1	3 (BH02, BH07 and BH08)
Benzo(a)pyrene	<0.01	6	0.02	None
Total PAH	0.03 – 612.0	6	< LOD	6 (WS5, WS6, WS7, BH02, BH07, and BH08)
Benzene	<1.0 – 3.5	6	10.0	None
Toluene	<1.0 – 6.9	6	74.0	None
TPH-CWG Aliphatic and Aromatic bands	<140.0 – 3400.0	6	10.0	3 (BH02, BH07 and BH08)

Three groundwater samples were submitted for VOC analysis as part of the 2020 investigation. The samples analysed included groundwater recovered from BH02, BH07 and BH08. The results of the contaminants with concentrations above the LOD are presented below.

Chemical Analysis VOCs within Groundwater

Contaminant	Result Range (µg/l)	Results Above LOD
Benzene	< 1.0 – 3.5	BH02 and BH08
Toluene	< 1.0 – 6.9	BH08
Ethylbenzene	< 1.0 – 81.1	BH02 and BH08
p & m-Xylene	< 1.0 – 170.0	BH08
o-Xylene	< 1.0 – 76.7	BH02 and BH08
Isopropylbenzene	< 1.0 – 4.4	BH08
1,3,5-Trimethylbenzene	< 1.0 – 19.1	BH08
1,2,4-Trimethylbenzene	< 1.0 – 41.9	BH02 and BH08

Assessment of risks to human health and property

Ground Gas

Pollutant linkages associated with risks from ground gas and vapour to the property and to human health have been assed using BS 8485:2015+A1:2019 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. The results are set out below.

The measured concentrations of hydrocarbons in groundwater have been compared with the SoBRA groundwater vapour GAC derived to assess the potential risk to human health from vapours generated from groundwater contaminants, based on a commercial end use. The results are set out below.

An assessment for whether barrier pipework was likely to be required as part of the development was undertaken by directly comparing the results from the soil testing with the PE, metal and barrier pipe thresholds. The table showing the assessment is also provided below.

Summary of Gas Monitoring Results.

Exploratory hole	Max Steady Flow (l/hr)	Max Steady Methane (%)	Max Steady Carbon Dioxide (%)	Minimum Oxygen (%)	Max Steady VOC (ppm)	Atmospheric Pressure Range (mbar)
BH1- J	0.5	<0.1	0.3	10.8	<0.1	988 - 1030
BH2 J	0.7	<0.1	0.1	20.3	NA	1016
BH3 - J	0.9	<0.1	0.8	19.1	<0.1	988 - 1028
WS2 - J	0.7	<0.1	0.3	20.0	<0.1	999 - 1024
WS7 - J	<0.1	<0.1	<0.1	15.0	0.2	1000 - 1021
WS3	0.9	<0.1	0.2	18.2	NA	1026
WS4	0.8	<0.1	0.9	20.0	NA	1024
WS5	0.9	<0.1	4.8	13.4	NA	1024 – 1026
WS6	0.8	0.4	0.6	14.7	NA	1024 – 1026
WS7	0.3	2.1	10.5	<0.1	2.4	988 - 1027
WS8	0.3	<0.1	0.4	19.7	NA	1024
BH02	<0.1	0.1	0.9	18.9	1.0	985 - 1022
BH07	<0.1	<0.1	0.2	11.7	0.6	988 - 1021
BH08 (S)	0.1	<0.1	1.9	19.9	6.0	988 - 1021
BH08 (D)	0.3	<0.1	0.3	20.2	2.8	988 - 1021

The concentration of methane was relatively low in all boreholes. The highest result was found in WS7 of 2.1% by volume in air (v/v).

The concentrations of carbon dioxide in each borehole ranged between <0.1% and 10.5% v/v. The highest result was found in WS7.

Hydrogen sulphide concentrations were found to be below the limit of detection.

The concentration of carbon monoxide ranged between <0.1 to 13.0ppm with the greatest concentration in BH02.

Vapour

Vapour Assessment.

Contaminant	Result (µg/l)	GACgwvap (µg/l)	Exceedances
Mercury	< 0.05	1.1	None
Naphthalene	< 0.01 – 585.00	220	1 (BH08 at 4.8mbgl)
Acenaphthylene	< 0.01 – 0.87	220000	None
Acenaphthene	< 0.01 – 13.70	170000	None
Fluorene	< 0.01 – 5.13	210000	None
Benzene	< 1.00 – 3.50	210	None
Toluene	< 1.00 – 6.90	230000	None
Ethylbenzene	< 1.00 – 81.10	10000	None
Xylenes	< 1.00 – 170.00	9500	None
MTBE	< 1.00	83000	None
TPH Aliphatic >C5 - C6	< 1.00	1900	None
TPH Aliphatic >C6 - C8	< 1.00	1500	None
TPH Aliphatic >C8 - C10	< 1.00	57	None
TPH Aliphatic >C10 - C12	< 10.00	37	None
TPH Aromatic >C5 - C7	< 1.00 – 3.50	210000	None
TPH Aromatic >C7 - C8	< 1.00 – 6.90	220000	None
TPH Aromatic >C8 - C10	< 1.00 – 390.00	1900	None
TPH Aromatic >C10 - C12	< 10.00 – 1500.00	6800	None
TPH Aromatic >C12 - C16	< 10.00 – 1000.00	39000	None

Drinking water supply pipework

Barrier Pipework Assessment.

Parameter Group	Testing Required	PE Pipe Threshold (mg/kg)	Metal or Barrier Pipe Threshold	Result	Outcome
Total VOC	Where preliminary risk assessment has identified land potentially affected by contamination	0.5	No Limit	<LOD	Pass
Total BTEX and MTBE		0.1	No Limit	<LOD	Pass
Total SVOC		2	No Limit	N/A	N/A
TPH >C5-C10		2	No Limit	<LOD	Pass
TPH >C10-C16		10	No Limit	<LOD – 473.0	Fail
TPH >C16-C40		500	No Limit	<LOD – 2950.0	Fail
Phenols (SVOC analysis)		2	No Limit	N/A	N/A
Cresols and chlorinated phenols from SVOC analysis		2	No Limit	N/A	N/A
Ethers	Only where identified from former land use	0.5	No Limit	N/A	N/A
Nitrobenzene		0.5	No Limit	N/A	N/A
Ketones		0.5	No Limit	N/A	N/A
Aldehydes		0.5	No Limit	N/A	N/A
Amines		<LOD	No Limit	N/A	N/A
Corrosive indicators, pH, conductivity EC and redox potential Eh	Where metal pipes are contemplated	No Limit	Wrapped steel: corrosive if pH<7 and EC>400uS/cm. Wrapped ductile iron corrosive if pH<5, Eh not neutral and EC>400uS/cm. Copper: corrosive if pH<5 and Eh positive	N/A	N/A
Presence of liquid free phase hydrocarbons	Observation	None allowed	None allowed	Sheen identified in Made Ground	Fail

3.0 APPENDIX 3: PRELIMINARY WASTE CLASSIFICATION

Waste Classification Report

483D8-V9C5D-TR96Y

Job name

YE7331

Description/Comments

Project

YE7331

Site

Bulls Bridge Industrial Estate, Hayes

Related Documents

#	Name	Description
None		

Waste Stream Template

Example waste stream template for contaminated soils

Classified by

Name:
Rachel Giles
Date:
18 Jul 2019 10:30 GMT
Telephone:
01243 787 150

Company:
YourEnvironment
Unit 6, Chilgrove Business Centre
Chilgrove Park Road
Chichester
PO18 9HU

Report

Created by: Rachel Giles
Created date: 18 Jul 2019 10:30 GMT

Job summary

Classification of sample: WS1

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	LoW Code:
WS1	Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	
0.75 m	Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 0% No Moisture Correction applied (MC)

#	Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		32	mg/kg	1.32	42.25	mg/kg	0.00423 %		
2	cadmium { cadmium oxide }	048-002-00-0	215-146-2	1306-19-0		0.2	mg/kg	1.142	0.228	mg/kg	0.0000228 %		
3	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		16	mg/kg	1.462	23.385	mg/kg	0.00234 %		
4	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<2	mg/kg	1.923	<3.846	mg/kg	<0.000385 %		<**LOD**
5	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		105	mg/kg	1.126	118.218	mg/kg	0.0118 %		
6	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	28	mg/kg	1.56	43.675	mg/kg	0.0028 %		
7	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<1	mg/kg	1.353	<1.353	mg/kg	<0.000135 %		<**LOD**
8	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		41	mg/kg	2.976	122.027	mg/kg	0.0122 %		
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				<3	mg/kg	2.554	<7.661	mg/kg	<0.000766 %		<**LOD**
10	zinc { zinc chromate }	024-007-00-3				54	mg/kg	2.774	149.804	mg/kg	0.015 %		
11	TPH (C6 to C40) petroleum group			TPH		<42	mg/kg		<42	mg/kg	<0.0042 %		<**LOD**
12	benzene	601-020-00-8	200-753-7	71-43-2		<2	mg/kg		<2	mg/kg	<0.0002 %		<**LOD**
13	toluene	601-021-00-3	203-625-9	108-88-3		<5	mg/kg		<5	mg/kg	<0.0005 %		<**LOD**
14	ethylbenzene	601-023-00-4	202-849-4	100-41-4		<2	mg/kg		<2	mg/kg	<0.0002 %		<**LOD**

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
15		xylene				<2	mg/kg		<2	mg/kg	<0.0002 %		<**LOD**
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
16		cyanides { salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex }				<2	mg/kg	1.884	<3.768	mg/kg	<0.000377 %		<**LOD**
		006-007-00-5											
17		pH				7.5	pH		7.5	pH	7.5 pH		
				PH									
18		naphthalene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
		601-052-00-2	202-049-5	91-20-3									
19		acenaphthylene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
			205-917-1	208-96-8									
20		acenaphthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
			201-469-6	83-32-9									
21		fluorene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
			201-695-5	86-73-7									
22		phenanthrene				0.23	mg/kg		0.23	mg/kg	0.000023 %		
			201-581-5	85-01-8									
23		anthracene				0.15	mg/kg		0.15	mg/kg	0.000015 %		
			204-371-1	120-12-7									
24		fluoranthene				0.25	mg/kg		0.25	mg/kg	0.000025 %		
			205-912-4	206-44-0									
25		pyrene				0.24	mg/kg		0.24	mg/kg	0.000024 %		
			204-927-3	129-00-0									
26		benzo[a]anthracene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
		601-033-00-9	200-280-6	56-55-3									
27		chrysene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
		601-048-00-0	205-923-4	218-01-9									
28		benzo[b]fluoranthene				0.37	mg/kg		0.37	mg/kg	0.000037 %		
		601-034-00-4	205-911-9	205-99-2									
29		benzo[k]fluoranthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
		601-036-00-5	205-916-6	207-08-9									
30		benzo[a]pyrene; benzo[def]chrysene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
		601-032-00-3	200-028-5	50-32-8									
31		indeno[123-cd]pyrene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
			205-893-2	193-39-5									
32		dibenz[a,h]anthracene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
		601-041-00-2	200-181-8	53-70-3									
33		benzo[ghi]perylene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<**LOD**
			205-883-8	191-24-2									
34		phenol				<2	mg/kg		<2	mg/kg	<0.0002 %		<**LOD**
		604-001-00-2	203-632-7	108-95-2									
										Total:	0.0558 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Classification of sample: WS2

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	LoW Code:
WS2	Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	
0.50 m	Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 0% No Moisture Correction applied (MC)

#	Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		20	mg/kg	1.32	26.407	mg/kg	0.00264 %		
2	cadmium { cadmium oxide }	048-002-00-0	215-146-2	1306-19-0		0.4	mg/kg	1.142	0.457	mg/kg	0.0000457 %		
3	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		26	mg/kg	1.462	38	mg/kg	0.0038 %		
4	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<2	mg/kg	1.923	<3.846	mg/kg	<0.000385 %		<LOD
5	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		87	mg/kg	1.126	97.952	mg/kg	0.0098 %		
6	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	146	mg/kg	1.56	227.733	mg/kg	0.0146 %		
7	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<1	mg/kg	1.353	<1.353	mg/kg	<0.000135 %		<LOD
8	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		24	mg/kg	2.976	71.43	mg/kg	0.00714 %		
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				<3	mg/kg	2.554	<7.661	mg/kg	<0.000766 %		<LOD
10	zinc { zinc chromate }	024-007-00-3				210	mg/kg	2.774	582.571	mg/kg	0.0583 %		
11	TPH (C6 to C40) petroleum group			TPH		49	mg/kg		49	mg/kg	0.0049 %		
12	benzene	601-020-00-8	200-753-7	71-43-2		<2	mg/kg		<2	mg/kg	<0.0002 %		<LOD
13	toluene	601-021-00-3	203-625-9	108-88-3		<5	mg/kg		<5	mg/kg	<0.0005 %		<LOD
14	ethylbenzene	601-023-00-4	202-849-4	100-41-4		<2	mg/kg		<2	mg/kg	<0.0002 %		<LOD

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
15		xylene				<2	mg/kg		<2	mg/kg	<0.0002 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
16		cyanides { salts of hydrogen cyanide with the exception of complex cyanides such as ferrocyanides, ferricyanides and mercuric oxycyanide and those specified elsewhere in this Annex }				<2	mg/kg	1.884	<3.768	mg/kg	<0.000377 %		<LOD
		006-007-00-5											
17		pH				7.5	pH		7.5	pH	7.5 pH		
				PH									
18		naphthalene				0.41	mg/kg		0.41	mg/kg	0.000041 %		
		601-052-00-2	202-049-5	91-20-3									
19		acenaphthylene				0.25	mg/kg		0.25	mg/kg	0.000025 %		
			205-917-1	208-96-8									
20		acenaphthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
			201-469-6	83-32-9									
21		fluorene				0.14	mg/kg		0.14	mg/kg	0.000014 %		
			201-695-5	86-73-7									
22		phenanthrene				0.85	mg/kg		0.85	mg/kg	0.000085 %		
			201-581-5	85-01-8									
23		anthracene				0.48	mg/kg		0.48	mg/kg	0.000048 %		
			204-371-1	120-12-7									
24		fluoranthene				2.35	mg/kg		2.35	mg/kg	0.000235 %		
			205-912-4	206-44-0									
25		pyrene				2.22	mg/kg		2.22	mg/kg	0.000222 %		
			204-927-3	129-00-0									
26		benzo[a]anthracene				1.66	mg/kg		1.66	mg/kg	0.000166 %		
		601-033-00-9	200-280-6	56-55-3									
27		chrysene				1.47	mg/kg		1.47	mg/kg	0.000147 %		
		601-048-00-0	205-923-4	218-01-9									
28		benzo[b]fluoranthene				1.94	mg/kg		1.94	mg/kg	0.000194 %		
		601-034-00-4	205-911-9	205-99-2									
29		benzo[k]fluoranthene				0.58	mg/kg		0.58	mg/kg	0.000058 %		
		601-036-00-5	205-916-6	207-08-9									
30		benzo[a]pyrene; benzo[def]chrysene				1.28	mg/kg		1.28	mg/kg	0.000128 %		
		601-032-00-3	200-028-5	50-32-8									
31		indeno[123-cd]pyrene				1.09	mg/kg		1.09	mg/kg	0.000109 %		
			205-893-2	193-39-5									
32		dibenz[a,h]anthracene				0.11	mg/kg		0.11	mg/kg	0.000011 %		
		601-041-00-2	200-181-8	53-70-3									
33		benzo[ghi]perylene				0.81	mg/kg		0.81	mg/kg	0.000081 %		
			205-883-8	191-24-2									
34		phenol				<2	mg/kg		<2	mg/kg	<0.0002 %		<LOD
		604-001-00-2	203-632-7	108-95-2									
										Total:	0.106 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Supplementary Hazardous Property Information

HP 3(i): Flammable "flammable liquid waste: liquid waste having a flash point below 60°C or waste gas oil, diesel and light heating oils having a flash point > 55°C and <= 75°C"

Force this Hazardous property to non hazardous because No free product on PID

Hazard Statements hit:

Flam. Liq. 3; H226 "Flammable liquid and vapour."

Because of determinand:

TPH (C6 to C40) petroleum group: (conc.: 0.0049%)

Classification of sample: WS3

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
WS3
Sample Depth:
0.75 m

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 0% No Moisture Correction applied (MC)

#	Determinand	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number / EC Number / CAS Number							
1	arsenic { arsenic trioxide }		19 mg/kg	1.32	25.086 mg/kg	0.00251 %		
	033-003-00-0 / 215-481-4 / 1327-53-3							
2	cadmium { cadmium oxide }		0.2 mg/kg	1.142	0.228 mg/kg	0.0000228 %		
	048-002-00-0 / 215-146-2 / 1306-19-0							
3	chromium in chromium(III) compounds { chromium(III) oxide }		23 mg/kg	1.462	33.616 mg/kg	0.00336 %		
	/ 215-160-9 / 1308-38-9							
4	chromium in chromium(VI) compounds { chromium(VI) oxide }		<2 mg/kg	1.923	<3.846 mg/kg	<0.000385 %		<LOD
	024-001-00-0 / 215-607-8 / 1333-82-0							
5	copper { dicopper oxide; copper (I) oxide }		76 mg/kg	1.126	85.568 mg/kg	0.00856 %		
	029-002-00-X / 215-270-7 / 1317-39-1							
6	lead { lead chromate }	1	381 mg/kg	1.56	594.29 mg/kg	0.0381 %		
	082-004-00-2 / 231-846-0 / 7758-97-6							
7	mercury { mercury dichloride }		1.1 mg/kg	1.353	1.489 mg/kg	0.000149 %		
	080-010-00-X / 231-299-8 / 7487-94-7							
8	nickel { nickel chromate }		22 mg/kg	2.976	65.478 mg/kg	0.00655 %		
	028-035-00-7 / 238-766-5 / 14721-18-7							
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }		<3 mg/kg	2.554	<7.661 mg/kg	<0.000766 %		<LOD
	034-002-00-8 / /							
10	zinc { zinc chromate }		211 mg/kg	2.774	585.345 mg/kg	0.0585 %		
	024-007-00-3 / /							
11	TPH (C6 to C40) petroleum group		<42 mg/kg		<42 mg/kg	<0.0042 %		<LOD
	/ / TPH							
12	benzene		<2 mg/kg		<2 mg/kg	<0.0002 %		<LOD
	601-020-00-8 / 200-753-7 / 71-43-2							
13	toluene		<5 mg/kg		<5 mg/kg	<0.0005 %		<LOD
	601-021-00-3 / 203-625-9 / 108-88-3							
14	ethylbenzene		<2 mg/kg		<2 mg/kg	<0.0002 %		<LOD
	601-023-00-4 / 202-849-4 / 100-41-4							

4.0 APPENDIX 4: MATERIAL IMPORTATION CRITERIA

Import Criteria

Contaminant	Reuse Criteria (1% SOM mg/kg)	Source
Non-Metals		
Asbestos	No detectable fibres	LOD
Metals		
Arsenic	168	C4SL
Cadmium	880	S4UL
Chromium	33000	S4UL
Hexavalent Chromium	168	C4SL
Copper	100	BS3882
Lead	1300	C4SL
Mercury (inorganic)	240	S4UL
Nickel	60	BS3882
Selenium	1800	S4UL
Zinc	<200	BS3882
Polyaromatic Hydrocarbons		
Naphthalene	1200	S4UL
Acenaphthylene	29000	S4UL
Acenaphthene	29000	S4UL
Fluorene	20000	S4UL
Phenanthrene	6200	S4UL
Anthracene	150000	S4UL
Fluoranthene	6300	S4UL
Pyrene	15000	S4UL
Benzo(a)pyrene	21	C4SL

Contaminant	Reuse Criteria (1% SOM mg/kg)	Source
Polyaromatic Hydrocarbons		
TPH-CWG - Aliphatic >EC5 - EC6	3200	S4UL
TPH-CWG - Aliphatic >EC6 - EC8	7800	S4UL
TPH-CWG - Aliphatic >EC8 - EC10	2000	S4UL
TPH-CWG - Aliphatic >EC10 - EC12	9700	S4UL
TPH-CWG - Aliphatic >EC12 - EC16	59000	S4UL
TPH-CWG - Aliphatic >EC16 – EC35	1600000	S4UL
TPH-CWG - Aliphatic >EC35 – EC44	1600000	S4UL
TPH-CWG - Aromatic >EC5 - EC7	26000	S4UL
TPH-CWG - Aromatic >EC7 - EC8	56000	S4UL
TPH-CWG - Aromatic >EC8 - EC10	3500	S4UL
TPH-CWG - Aromatic >EC10 - EC12	16000	S4UL
TPH-CWG - Aromatic >EC12 - EC16	36000	S4UL
TPH-CWG - Aromatic >EC16 - EC21	28000	S4UL
TPH-CWG - Aromatic >EC21 - EC35	28000	S4UL
TPH-CWG - Aromatic >EC35 – EC44	28000	S4UL

5.0 APPENDIX 5: EXTENT OF SURVEY LIMITATIONS AND DEFINITIONS

EXTENT OF SURVEY AND LIMITATIONS

This report is for your sole use, and consequently no responsibility whatsoever is undertaken or accepted to any third party for the whole or any part of its contents. Paragon accept no responsibility or liability for the consequences of this document being used for any purpose or project other than for which it was commissioned or a third party with whom an agreement has not been executed. Should any third party which to use or rely upon the contents of the report, written approval must be sought from Paragon, a charge may be levied against such approval.

The report has been designed to address potential source, pathway and receptor pollutant linkages associated with the proposed development. The content and findings of the report are based on data obtained by employing site assessment methods and techniques, considered appropriate to the site as far as can be interpreted from desk-based materials and a visual walkover of the site. Such techniques and methods are subject to limitations and constraints set out in the report. The findings and opinions are relevant at the time of writing, and should not be relied upon at a substantially later date as site conditions can changes. For example, seasonal groundwater levels, natural degradation of contaminants etc.

No liability can be accepted for the conditions that have not been revealed by the exploratory hole locations, or those which occur between each location. Whilst every effort will be made to interpolate the conditions between exploratory locations, such information is only indicative and liability cannot be accepted for its accuracy. By their nature, exploratory holes provide a relatively small and localised snapshot of the ground conditions relative to the size of the site.

Specific comment is made regarding the site's status under Part 2A of the Environmental Protection Act (EPA) 1990, which provides a statutory definition of Contaminated Land and as revised under The Contaminated Land (England) (Amendment) Regulations 2012. Unless specifically stated as relating to this definition, references to 'contamination' and 'contaminants' relate in general terms to the presence of potentially hazardous substances in, on or under the site.

The opinions given within this report have been dictated by the finite data on which they are based and are relevant only to the purpose for which the report was commissioned. If additional information or data becomes available which may affect the opinions expressed in this report, Paragon reserves the right to review such information and, if warranted, to modify the opinions accordingly. Paragon reserves the right to charge additional fees for; un-anticipated second opinion reviewing of previous reports.

Paragon has prepared this report with reasonable skill, care and diligence. The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted industry practices at this time. The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources. We cannot provide guarantees or warranties for the accuracy of third-party data, which is reviewed in good faith and assumed to be representative and accurate.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed. No liability can be accepted for the effects of any future changes to such guidelines and legislation. In the event that guidance / legislation changes it may be necessary for Paragon to update or modify reports. The risk assessment is completed in line with the relevant land use agreed for the site and the time of completing the works. Changes to site conditions or land use may require a reassessment.

DEFINITIONS

For the avoidance of doubt, Paragon Building Consultancy Limited (Paragon) has prepared the following alphabetical list of definitions and reservations to aid the client in understanding the content of our advice and or written reports(s):

Accuracy	Level of agreement between true value and observed value.
ACM's	Asbestos Containing Materials
Conceptual site model	Textual and or schematic hypothesis of the nature and sources of contamination, potential migration pathways (including description of the ground and groundwater) and potential receptors, developed on the base of the information from the preliminary investigation and refined during subsequent phases of investigation and which is an essential part of the risk assessment process. **Note 1:** The conceptual exposure model is initially derived from the information obtained by the preliminary investigation. This conceptual model is used to focus subsequent investigations, where these are considered to be necessary, in order to meet the objectives of the investigations and the risk assessment. The results of the field investigation can provide additional data that can be used to further refine the conceptual model.
Contamination	Presence of a substance which is in, on or under land, and which has the potential to cause significant harm or to cause significant pollution of controlled water. **Note 1:** There is no assumption in this definition that harm results from the presence of the contamination. **Note 2:** Naturally enhanced concentrations of harmful substances can fall within this definition of contamination. **Note 3:** Contamination may relate to soils, groundwater or ground gas.
Controlled water	Inland freshwater (any lake, pond or watercourse above the freshwater limit), water contained in underground strata and any coastal water between the limit of highest tide or the freshwater line to the three-mile limit of territorial waters. **Note 1:** See Section 104 of The Water Resources Act 1991.
Enquiries	Any enquiries undertaken by Paragon of local authorities and statutory undertakers are made verbally in respect of environmental issues. Local searches are not undertaken and no responsibility is accepted for any inaccurate information provided.
Harm	It is further assumed unless otherwise stated that all necessary licences, permits etc either run with the property or are transferable to a new occupier as appropriate. Adverse effect on the health of living organisms, or other interference with ecological systems of which they form part, and, in the case humans, including property.
Hazard	Inherently dangerous quality of a substance, procedure or event.
Pathway	Mechanism or route by which a contaminant comes into contact with, or otherwise affects, a receptor.
Precision	Level of agreement within a series of measurements of a parameter.

Receptor	Persons, living organisms, ecological systems, controlled water, atmosphere, structures and utilities that could be adversely affected by the contaminant(s).
Risk	Probability of the occurrence, magnitude and consequences of an unwanted adverse effect on a receptor.
Risk assessment	Process of establishing, to the extent possible, the existence, nature and significance of risk.
Sampling	Methods and techniques used to obtain a representative sample of the material under investigation.
Soil	Upper layer of the earth's crust composed of mineral parts, organic substance, water, air and living matter. **Note 1:** In general accordance with BS 10175:2001 the term soil has the meaning ascribed to it through general use in civil engineering and includes topsoil and subsoil; deposits such as clays, silt, sand, gravel, cobbles, boulders and organic deposits such as peat; and material of natural or human origin (e.g. fills and deposited wastes). The term embraces all components of soil, including mineral matter, organic matter, soil gas and moisture, and living organisms.
Source	Location from which contamination is, or was, derived. **Note 1:** This could be the location of the highest soil or groundwater concentration of the contaminant(s).
Uncertainty	Parameter, associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurement.