

Westchurch Homes

REMEDIATION STRATEGY

for

Brunswick Street, Heywood

September 2022

REPORT No: 21WCH018/RS

- *Desk Studies and Site Walkovers*
- *Intrusive Contaminated Land Investigations*
- *Geotechnical Appraisals and Ground Investigations*
- *Landfill Gas Assessments and Remedial Design*
- *Remediation Design and Implementation*
- *Remediation Project Management and Supervision*
- *Site Abnormal Assessments (Foundations and contaminated land)*
- *Ecological Surveys (Bats, Badgers, Newts, Japanese Knotweed etc)*

GEOTECHNICAL - CONTAMINATED LAND - FLOOD RISK

© Betts Geo Environmental Ltd 2022

DOCUMENT ISSUE RECORD

Contract No:	21WCH018/RS
Westchurch	Westchurch Homes
Contract:	Brunswick Street, Heywood
Document:	Remediation Strategy

Prepared by:  J Skues

Checked by:  B Lewis

Authorised by:  M Fawcett

Date: Sep 2022

REVISION RECORD

Revision	Date	Description	Prepared by
0	Sep 22	Draft for comment	JS

TABLE OF CONTENTS

1. INTRODUCTION	4
The Commission and Brief	4
2 Background.....	6
2.1 Site Description	6
2.2 Site History	6
2.3 Geology	6
2.4 Hydrogeology and Hydrology	7
2.5 Summary of Ground Investigations	7
3 REMEDIAL ACTIONS.....	14
3.1 Removal of Contaminated Water within Vicinity of WS207	14
3.2 Site Won Soils and Imported Soils	15
3.3 Controlled Waters/Groundwaters	17
3.4 Gas Protection Measures	17
3.5 Construction / Maintenance Workers	18
3.6 Drinking Water Supplies	18
3.7 Review of Conceptual Site Model.....	19
4 SITE PREPARATION AND ENABLING WORKS	21
4.1 Site Set-up, Organisation and Safety	21
4.2 Site Clearance	23
4.3 Excavation of Hardstanding and Foundations	23
4.4 Excavation of Footings	24
4.5 Arisings.....	24
4.6 Dust, Vapour & Odour Control.....	24
4.7 Odour Monitoring.....	24
4.8 Trigger Levels.....	25
4.9 Mitigation	25
4.10 Export to Landfill.....	26
4.11 Backfill of Excavations.....	26
4.12 Boundary Issues.....	26
4.13 Highways.....	26
4.14 Protection of Buried Concrete	27
4.15 Control of Groundwater	27
4.16 Contingency for Unknown	28
4.17 Site Certification	28
5 REMEDIATION HOLD POINTS	29

1. INTRODUCTION

The Commission and Brief

Betts Geo Environmental (Betts) has been commissioned by Westchurch Homes to prepare a Remediation Strategy for the remediation and preparatory works for the Brunswick Street, Heywood site. The plan below shows the site boundary;



This Remediation Strategy has been prepared for the purpose of demonstrating to the Local Planning Authority the remediation methodology going throughout the duration of the development.

Regulatory approval is advised prior to site commencement.

Betts reserves the right to amend this remedial strategy in the light of further information, such as site observations and unforeseen conditions.

1.2 Proposed Development

The proposed development at time of issue comprises the construction of residential dwellings with associated gardens, public open space and other infrastructure.

1.3 Previous Betts Reporting

The following reports have been used in order to inform the remediation strategy:

- Betts Geo, Desk Study Report for Brunswick Street, Heywood - July 2021, Report No. 21WCH018/DS, Rev 0

- Betts Geo, Ground Investigation Report for Brunswick Street, Heywood – November 2021, Report No. 21WCH018/GI, Rev A

Where necessary the above reports have been used throughout this report and referenced accordingly. The following 'Site History Summary', 'Geology' and 'Environmental Data' has been summarised from the report.

The following sections have been based on the investigation undertaken to date (pre demo), however an additional phase of site investigation is required post demolition to fully assess the extent of the contamination across site with future revision of this document on completion of the additional works.

2 Background

2.1 Site Description

Site comprises a derelict Rope Works once used by IBEX Marina Ropes Ltd, built originally for Healey Brothers Ltd. The small parcel to the north is likely the office, with the remaining generally single storey workshops and manufacturing businesses to the south. It's understood from that the business manufactured natural ropes. Originally driving ropes for mills before moving on to twine, cotton rope, mill bandings, hemp twines and cords, cotton spinners, doublers, reelers, thrown yarns, cabled yarns, net yarns, net mounting cords. Specialities: cotton parcelling twines, main driving ropes, cotton belting yarns, plaited tubular bandings.

Access to the remaining mill building was not possible, and the walkover was undertaken from the boundary. Concrete hardstanding is generally encountered across the site. Site levels are generally level with a slight fall south to north.

2.2 Site History

The earliest available map is the 1851 1:10,560 map (note this map was surveyed in 1847) which shows Long Field Brickfield covering the southern portion of site, an access road/track is marked running across the north of site and two small buildings are shown in the north-west corner of site.

No major changes occur on site until the 1851 1:1,056 map (note this map was surveyed in 1848) and shows two new blocks or terraced houses on the west boundary of site and the brickfield is no longer shown therefore the brickmaking likely ceased on the site in 1848.

Circa 1890, the Carteridge Steam Ropery is shown occupying the majority of site, Ashton Street is shown orientated North-South across site, additional terraced housing is shown fronting Brunswick Street and Fox Street and isolated building with enclosure is shown in the south-east of site.

Circa 1908 – 1909, an additional building is shown in the north of site and the Steam Ropery building is shown extended over Ashton Street and down the eastern boundary of site. A circular feature is also shown which upon closer inspection of the 1910 1:2,500 map is marked as a gasometer. A chimney and glasshouse is also shown on this map. Circa 1929, the Cartridge Ropery complex has small extensions, and a tank is marked.

No further major changes occur onsite until the 1978 – 1984 1:1,250 map when the terraced housing fronting Fox Street and Brunswick Street in the north parcel of site are no longer shown. Circa 1988 – 1992, the remaining terraced houses onsite fronting Brunswick Street and the glasshouse in the south-west corner of site are no longer shown.

No further major changes occur onsite until the 2021 1:10,000 map when the west wing of the factory is reduced in length.

2.3 Geology

The documented geology of the site is summarised on the British Geological Survey map principally, with further site-specific details detailed below.

Geology	Artificial Ground & Land Slip	Drift	Solid
1:10,000	None Recorded*	Glaciofluvial Deposits – Sand & Gravel	North-East Corner of Site – Pennine Lower Coal Measures Formation – Sandstone Remainder of Site – Pennine Lower Coal Measures Formation – Mudstone, Siltstone & Sandstone

*due to the sites development history the presence of made ground cannot be discounted despite none being recorded on the Groundsure mapping.

2.4 Hydrogeology and Hydrology

- The superficial deposits of the Glaciofluvial Deposits are designated as a Secondary A Aquifer.
- The bedrock deposits of the Pennine Lower Coal Measures Formation is designated as Secondary A Aquifer.
- The site does not lie within a Source Protection Zone as defined by the Environment Agency.
- There are no licenced water abstractions within 500m of site.
- There are no surface water features identified on site.

2.5 Summary of Ground Investigations

Site investigation was undertaken by Betts Geo in September and December 2021 as detailed below;

2.5.1 Scope of Works

The initial fieldwork was carried out on the 28th to 30th September 2021, the investigation comprised of the following;

- Three (3 No.) machine excavated trial holes to between 3.50mbgl (TP1) and 3.40mbgl (TP2).
- Three (3 No.) cable percussive boreholes to depths of between 7.10mbgl (CP2) and 6.50mbgl (CP3) with all boreholes installed with monitoring wells.
- Six (6 No.) ground has monitoring visits over a period of at least three (3 No.) months with varying barometric pressures.
- Chemical analysis of nine (9 No.) samples for heavy metals, TPH's, PAH's, and asbestos.
- Five (5 No.) samples for geotechnical analysis.

Further investigation works were undertaken on 20th and 21st December 2021 when vegetation was cleared, and comprised;

- Ten (10 No.) window sample boreholes to depths of between 1.80mbgl (WS208) and 3.00mbgl with 4no. locations installed with gas monitoring wells. WS207 was stopped at 1.00mbgl due to contaminated water.
- Six (6 No.) ground has monitoring visits over a period of at least three (3 No.) months with varying barometric pressures.
- Chemical analysis of eleven (11 No.) samples for heavy metals, TPH's, PAH's, and asbestos.

Exploratory locations were positioned to investigate the potential contamination and geotechnical risks presented by the current and former site uses and to achieve a general site spread. The majority of the site was not accessible with no or limited access for the JCB excavator and cable rig in the southern parcel due to fences, buildings and vegetation. Trial pits were positioned in the accessible north parcel of site to achieve suitable spread with boreholes positioned to achieve as best site spread as possible considering the lack access, existing services and manoeuvrability restrictions of the rig.

2.5.2 Ground Conditions

Ground conditions generally consisted of hard black tarmac MADE GROUND to a maximum depth of 3.00mbgl (WS203) over either soft to firm olive green/grey brown slightly sandy CLAY to a maximum depth of 5.40mbgl (CP2) or dense brown yellow brown/brown fine to medium SAND to a maximum depth of 4.60mbgl (CP2) over hard yellow grey fine grained SILTSTONE proven to 7.10mbgl.

Topsoil

Topsoil was only encountered within CP3 as a thin layer to 0.1mbgl and was described as grass/moss over dark brown slightly sandy clay with rootlets. This stratum was encountered within an area of hardstanding and likely represent natural colonisation over.

Cohesive MADE GROUND

Made Ground predominantly comprising cohesive material was encountered across the site within the majority if the exploratory hole locations, with secondary constituent of fine angular gravel of brick, ash, limestone and concrete.

Cohesive Made Ground was encountered from depths between 0.00 and 0.20mbgl, proven to depths between 0.50m and 3.00mbgl (BNE).

Granular MADE GROUND

Granular Made Ground was encountered across site, encountered from surface to 0.10mbgl, and proven to depths between 1.00m and 2.50m bgl. Typically encountered as a Gravel with variable secondary and tertiary constituents of brick, sandstone, limestone, concrete, ash and clinker. The Made Ground was typically described as black ashy sandy GRAVEL, with the gravel described as slag, coal, clinker.

Glacial Till

Glacial Till was encountered within all locations that reached full depth. The Glacial Till encountered beneath made ground and interbedded between granular glaciofluvial deposits over the Siltstone bedrock.

There were several types of glacial till which were described as:

- Soft to firm olive green grey/brown slightly sandy silty CLAY.
- Soft to firm grey brown mottled blue grey slightly sandy CLAY with rare gravel.
- Soft grey sandy SILT.

Glaciofluvial Deposits

Granular glaciofluvial deposits were encountered across the site and was generally encountered below made ground from 1.20mbgl t 4.00mbgl, proven to depths between 2.90m and 5.50mbgl, achieving proven thicknesses of between 1.00m and 3.40mbgl.

There were several types of glacial till which were described as:

- Loose to medium grey fine to coarse SAND.
- Dense brown SAND & GRAVEL.
- Dense yellow brown coarse SAND.

Pennine Lower Coal Measure Formation

The Pennine Lower Coal Measures Formation was encountered in all cable percussive boreholes from 4.00 to 5.50mbgl and was noted as hard yellow grey fine-grained Siltstone recovered as fine to medium angular gravel. Due to the strength of this material the trial pit was terminated so the depth was not proven.

Visual and Olfactory Contamination

Made ground was often noted to comprise or contain as secondary constituents sandstone kerbs/lintels, brick, coal, slag, cinders, limestone gravel and tarmac which was encountered within all exploratory holes.

No olfactory evidence of contamination was noted. No other visual or olfactory signs of contamination were encountered during the initial site investigation.

The additional investigation highlighted one area of visual and olfactory contamination, as shown below;

Location	Depth (mbgl)	Description
WS207	0.60	Strata is wet with water and oil as free product and strong odour.

Obstructions

The following obstructions were encountered during the investigation:

- TP1, possible concrete floor at 0.5mbgl.
- TP3, brick wall in east side of pit (potential former basement).
- Natural obstruction from the Pennine Lower Coal Measures Formation in CP1, CP2 and CP3.
- WS206, Concrete, 0.15-0.30mbgl.
- WS208, Brick floor, 0.30-0.45mbgl.
- WS208 refusal on possible cobble sets at 1.80mbgl

2.5.3 Groundwater

The following exploratory holes encountered groundwater during the fieldwork:

Exploratory Hole	Depth (m bgl)	Strata	Remark
TP3	2.90	Glaciofluvial Deposits	Seepage and running sand.
CP1	1.00	MADE GROUND	Seepage.
WS201	2.10-2.50	MADE GROUND	Strata is wet.
WS202	1.50-1.70	MADE GROUND	Wet.
WS206	1.20	MADE GROUND	Wet
WS207	0.60	MADE GROUND	Standing water with oil free product

The following table indicates the groundwater monitoring notes during the post fieldwork monitoring (6/6 visits complete):

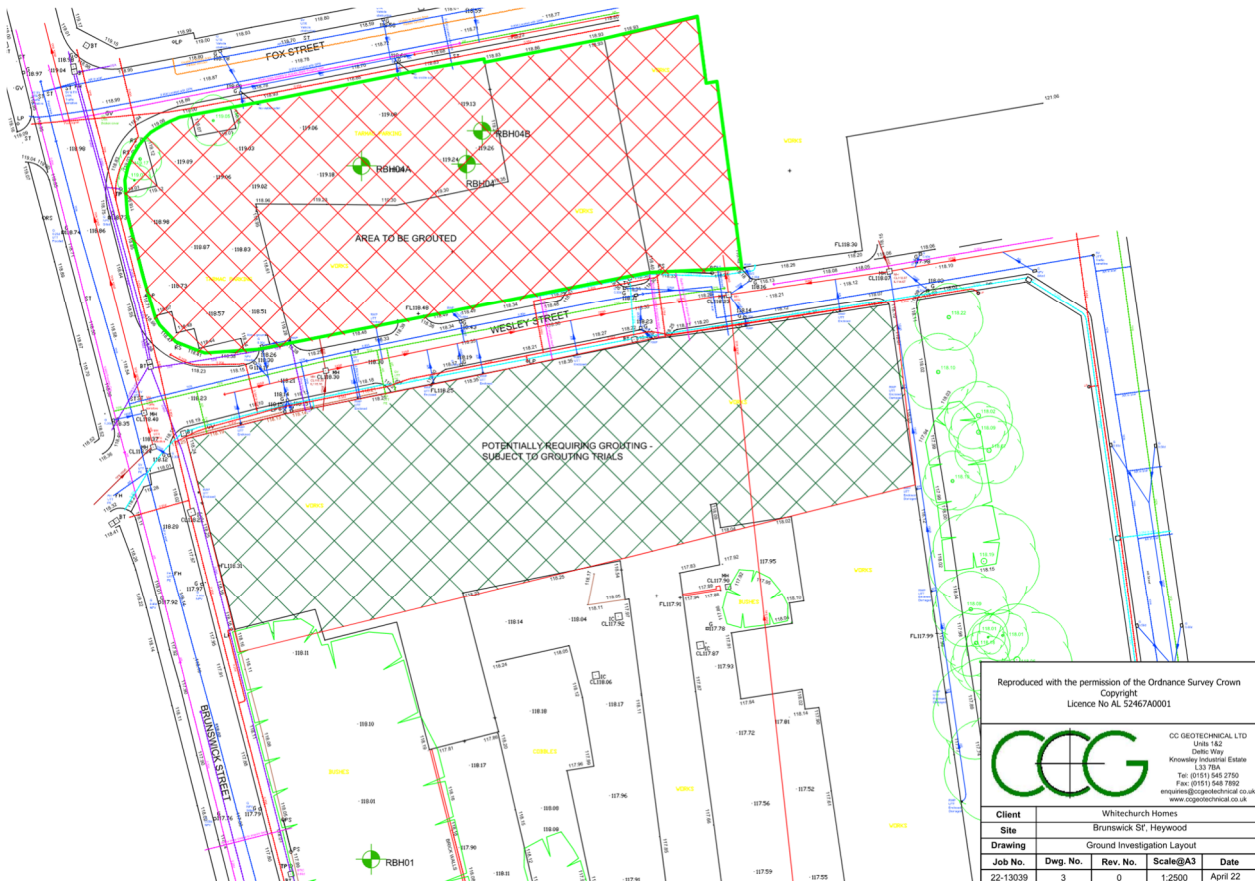
Exploratory Hole	Depth to Water (mbgl)		Borehole Depth (mbgl)		No. of Visits
	Min	Max	Min	Max	
CP1	0.50	Dry	4.30	5.10	6
CP2	0.50	Dry	4.75	5.10	6
CP3	1.20	Dry	4.35	4.80	6
WS201	1.50	2.00	2.45	2.85	6
WS203	1.70	Dry	2.75	2.95	6
WS208	Dry	Dry	1.40	1.75	6
WS209	1.90	Dry	2.40	3.10	6

2.6 Coal Investigation

Further rotary investigation was undertaken by CC Geotechnics and reported in report reference CCG-C-22-13039 dated June 2022.

Three rotary boreholes were undertaken across the site pre demolition. RBH04 encountered loss of flush at 24-26mbgl suggesting workings at this depth. Intact coal was encountered in RBH02 and 03 at both 14.3-14.7m and 21-22.8mbgl.

CCG advise that grouting treatment is required in the affected area. Trial grouting is also recommended in further areas due to the existing building still remaining in tact as shown in the drawing below:



The findings of the CCG Report should be agreed by the Coal Authority. Our foundation solutions and remediation recommendations are based on the above and should this change, reassessment will be required.

The coal investigation will have some bearing on the foundation solution as included within our previously undertaken SI report.

Given the likelihood for shallow coal workings in the northern area, a driven piled solution to bedrock is unlikely to be a suitable foundation solution. Given the depth of made ground on site, re-engineering of made ground along with either a raft or vibro stone column are likely to be required subject to specialist advice from a suitable contractor.

Consideration to the depth of made ground, nature of unforeseen buried obstructions, interbedded clay and sand strata, tree heave along with shallow perched groundwater should be undertaken.

Post demolition/crush/site turnover further consideration to vibro ground improvement may be possible, liaison with a suitable contractor should be undertaken to confirm.

Findings of the Coal Investigation and proposed remediation should be presented to the Coal Authority for their agreement.

2.6.1 Soil Contamination Encountered

Exceedances of arsenic, lead, asbestos and various hydrocarbons have been identified across the site within the Made Ground and are discussed below.

Asbestos has also been noted in one location (TP3 @ 0.20mbgl) which has been quantified to <0.001%.

Due to widespread hydrocarbons and metals, and isolated cases of asbestos, a 600mm clean cover (with a geotextile or hardcore break layer in the northern parcel shown below) to gardens, and 300mm clean cover to public open space / landscaped areas is advised to protect site end users.

Appropriate PPE should be worn in asbestos affected areas and dampening down of asbestos containing soils should be undertaken for any machine traffic. Further risk assessment should be carried out prior to construction starts.

If site levels do not allow for the installation of these cover systems the MADE GROUND can be disposed of to a suitably licensed facility. However, deep MADE GROUND has been noted in certain areas and a clean and inert cover system may still be required.

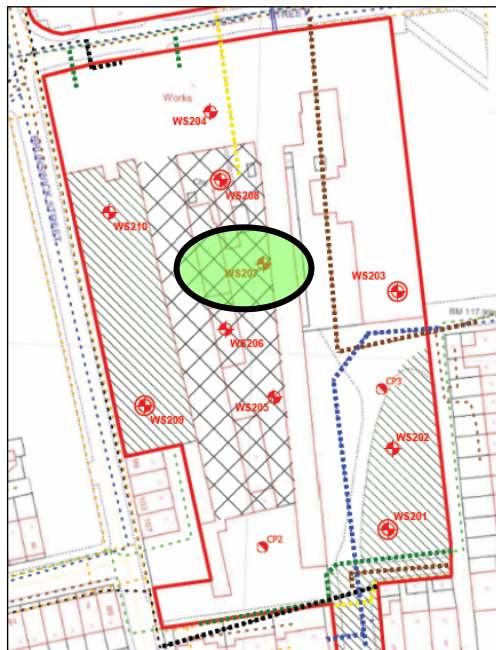


From the initial testing, the results have shown regularly contaminated made ground and a future phase will be required post demolition to fully assess the extent of the contamination across site with future revision of the revised conceptual site model and risk reduction/remediation strategy sections below on results return.

In particular, the area around WS207 will require careful demolition and investigation to ensure the contaminated water does not migrate. It is likely that this is perched water in this locality.

2.6.2 Surface Water, Groundwater and Aquifer Risk

Whilst small amounts of perched water were encountered during the site investigation works, the site is underlain by generally impervious cohesive strata and vertical migration is considered unlikely. Therefore, the risk is generally deemed as LOW. However, the risk for the area around WS207 is deemed as MODERATE.



Removal of the contaminated water in this area will require removal and validation with an accompanying validation report.

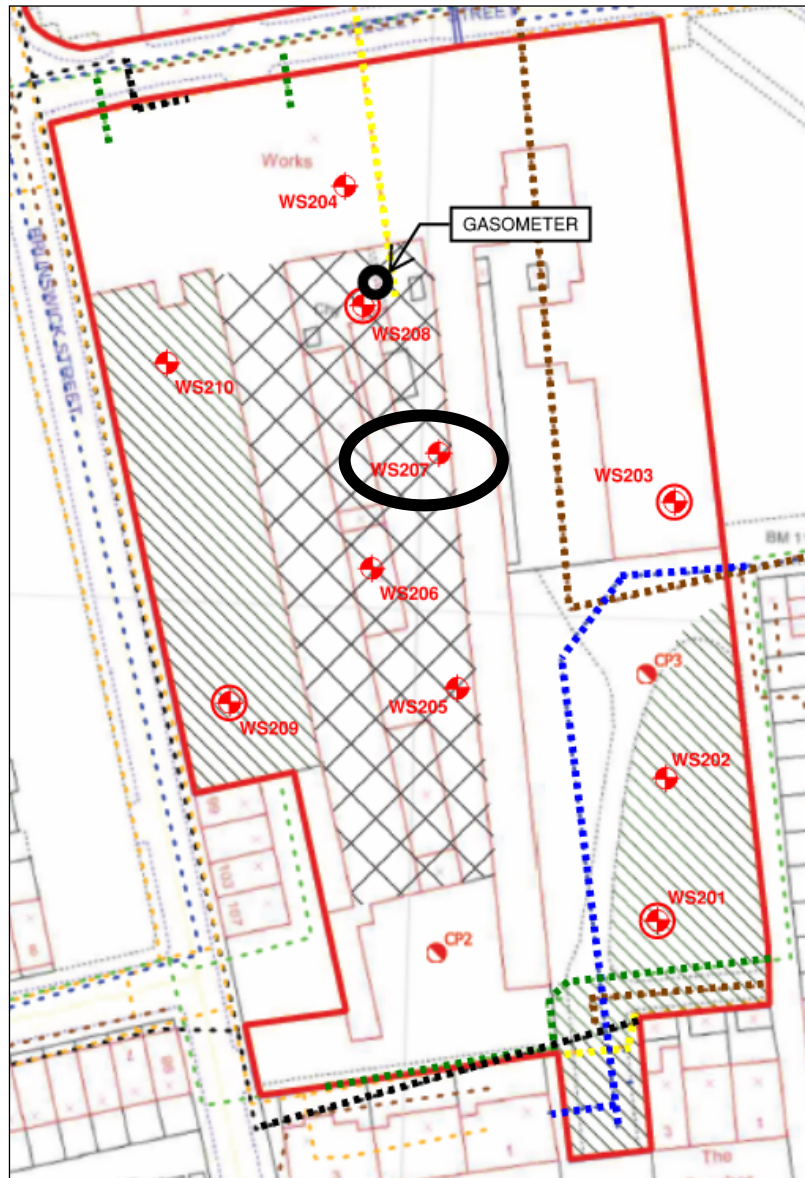
2.6.3 Ground Gas

Elevated carbon dioxide >5% (max value 6.5%) has been encountered in CP1-2 and WS203, with a maximum flow rate of 4.5l/hr indicating that Amber 1/CS2 ground gas protection measures will be required in the vicinity of these holes.

Based on these results it is recommended that Amber 1 / CS2 protection is required across the site.

Allowance for VOC resistance membrane and ventilated void is advised around former gasometer and WS207 until investigated further. This risk assessment should be updated following demolition and remediation of this area.

Site Area	Site Classification	Recommended Ground Gas Protection Measures
WS207 & Former Gasometer	Amber 1 / CS2 with hydrocarbon vapour resistant membrane	Low-level ground gas protection measures are required, using a hydrocarbon vapour resistant membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
Remainder of Site	Amber 1 / CS2	Low-level ground gas protection measures are required, using a membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.



3 REMEDIAL ACTIONS

The following sections have been based on the investigation undertaken to date, however an additional phase of site investigation is required post demolition to fully assess the extent of the contamination across site with future revision of this document on completion of the additional works.

Findings of the Coal Investigation and proposed remediation should be presented to the Coal Authority for their agreement.

3.1 Removal of Contaminated Hotspot within Vicinity of WS207

Free product was noted in the water encountered in WS207 in the form of oil with a strong hydrocarbon odour. This area will require careful demolition and investigation to ensure the contaminated water does not migrate. It is likely that this is perched water in this locality.

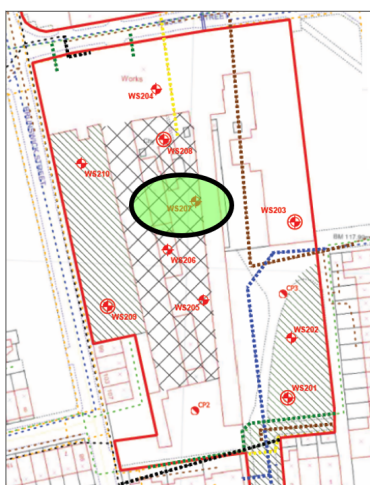
Concrete was also noted in this area, and the underlying soils could also be impacted. If underlying soils are found to be affected, the contaminated material should be excavated out and exported off site to a suitably licensed facility (or there is a possibility of stockpiling and turn over/vaporisation before chemical testing and possible re-use on site in less sensitive areas). The resultant void should be chemically tested at agreed spacings (e.g. 5m) to ensure all impacted material has been removed and then filled with a geotechnically suitable material.

The free product/groundwater can either be treated on site or tankered offsite. If the water/free product is to be treated on site, a suitable discharge point for any treated or untreated water to be disposed of under an appropriate license is to be agreed before any works begin. If free product/groundwater is to be pumped and tankered off site, it is recommended that the results of the contamination testing be presented to the proposed end site to obtain their acceptance of the information to date.

Demolition will be required in this area to access the hotspot area as concrete obstructions were also noted, however this should be the first action to be completed on site when demolition is undertaken due to its possible impact on the remainder of the site if left in situ or if it is disturbed during further earthworks.

A full watching brief is advised during the demolition of the buildings and liaison with remedial contractors to co-ordinate delineation and assessment during the demolition period.

Main area in question:

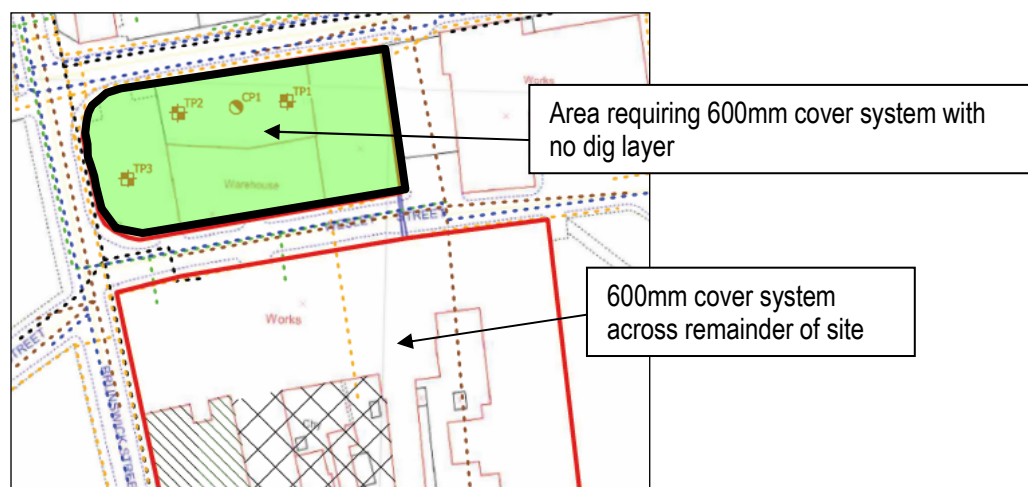


3.2 Site Won Soils and Imported Soils

Exceedances of arsenic, lead, asbestos and various hydrocarbons were identified across the site within the Made Ground across the areas investigated. Asbestos was also noted in one location (TP3 @0.2mbgl) which has been quantified to <0.001%.

Due to widespread hydrocarbons (although free product proposed for removal), metals, and isolated case of asbestos, a 600mm clean cover (with the addition of a geotextile or hardcore break layer in the northern parcel due to asbestos) to gardens, and 300mm clean cover to public open space / landscaped areas is advised to protect site end users.

If site levels do not allow for the installation of these cover systems the MADE GROUND can be and disposed of to a suitably licensed facility. However, deep MADE GROUND has been noted in certain areas and a clean and inert cover system may still be required.



Within Garden Areas (Northern Parcel)

150mm topsoil
450mm subsoil (free of coarse granular material in the upper 150mm) with no dig layer at base

Within Garden Areas (Rest of Site)

150mm topsoil
450mm subsoil (free of coarse granular material in the upper 150mm)

Within Soft Landscaped Areas

150mm topsoil
150mm subsoil (free of coarse granular material)

The above is proposed to comply with NHBC Chapter 9 regulations regarding physical composition of cover (i.e. no coarse granular material within the first 300mm) and exceeds the minimum requirement of 100mm depth of topsoil – extract from Ch9 below:

*'9.2 - S5 Garden areas shall be free from obstructions beneath the surface old foundations, concrete bases and similar obstructions occurring within 300mm of the finished ground surface should be removed.
9.2 - S6 Garden areas shall be adequately prepared for cultivation construction rubbish and debris should be removed from garden and other areas around the home. Garden areas should be provided with topsoil to a thickness of not less than 100mm. The topsoil should not contain contaminants which are likely to present a hazard to users of the garden area.'*

The use of site won soils is not anticipated given the sites history and contamination identified.

There is a significant visual difference between the Made Ground and the natural material, therefore the two materials can be stockpiled separately following excavation.

Any site won material will need to be chemically and visually assessed within the stockpile before being re-used in gardens. Confirmation of the testing will be required and is usually based on the ratios scheduled below. Full confirmation of testing ratios should be sought from the Local Authority.

Imported soil being brought to site should be tested for contamination to ensure it is suitable for the proposed use, and it is generally advisable to test a minimum of three samples per source, and to be in line the Local Authority's testing specification.

Intended End Use	Source / Origin of Material		
	Greenfield	Remediated	Brownfield / Unknown
Gardens	1:150m ³	1:100m ³	1:50m ³
Soft Landscaping	1:200m ³	1:150m ³	1:150m ³
Other	1:200m ³	1:200m ³	1:200m ³

Chemical analysis should be assessed using a desk study/details of historic use of the site where the imported soil originated. Chemical analysis is likely to include (but is not limited to); CLEA Metals (Arsenic, cadmium, chromium (Vi), lead, mercury, selenium, copper, nickel and zinc), pH values, Sulphate - soluble 2:1 extract, speciated polycyclic aromatic hydrocarbons (PAH), extractable petroleum hydrocarbons (EPH), TPH CWG, Asbestos screening and Organic matter.

This work may be undertaken as part of the contract for the preparatory & remedial works, in which case imported soils should be stockpiled in a location agreed with the Engineer. Alternatively, the Developer may choose to import soil at a later stage in the development.

In order to demonstrate that the required depth of 'clean' cover material has been placed across the required areas (i.e. within garden areas and areas of landscaping) a post-fill survey will be undertaken by hand-dug pits and provision of photographic evidence of the cover system within rear gardens. This will be provided to the contractor for their records.

It is suggested that given the garden size proposed, the simplest way to validate the soil is to sample 1 garden in 3 for imported topsoil and subsoil, along with a depth test in each plot to prove depth of cover is sufficient in garden areas.

Summary of what is required for imported material:

- Desk study undertaken to establish source
- Source used to determine sampling frequency / chemical analysis scheduling.
- Engineer to attend source site and collect representative samples for assessment.
- Samples analysed and screened for end use suitability for residential with root uptake.
- Validation from Local Authority for suitability.
- Import soil to site and place in garden areas to the agreed cover thickness.

- Engineer to attend site and undertake photographic cover thickness validation via hand dug exposure pits on the basis of 1:3 gardens. Report to be produced and submitted to the local Authority for approval.

An additional phase of site investigation is required post demolition to fully assess the extent of the contamination across site with future revision of this document on completion of the additional works.

3.3 Controlled Waters/Groundwaters

Whilst small amounts of perched water were encountered during the site investigation works, the site is underlain by generally impervious cohesive strata and vertical migration is considered unlikely. Therefore, the risk is generally deemed as LOW. However, the risk for the area around WS207 is deemed as MODERATE.

Demolition will be required in this area to access the hotspot area as concrete obstructions were also noted, however this should be the first action to be completed on site when demolition is undertaken. A full watching brief is advised during the demolition of the buildings and liaison with remedial contractors to co-ordinate delineation and assessment during the demolition period.

Extreme care is required to ensure the clay barrier to the Secondary A Aquifer remains intact during the remediation.

Should any visual or olfactory evidence of contamination be encountered in either groundwater or nearby surface waters during the remediation works, the area will be investigated further by a Betts Geo Environmental engineer and sampled as necessary. The Contaminated Land Officer at the Local Authority will also be notified if the material is deemed to represent a risk to environmental receptors or public health. Samples will be forwarded to a UKAS accredited laboratory for a suite of analytical testing deemed appropriate based upon a visual and olfactory appraisal of the material identified.

Once the results of any analysis are known, the required remedial action (if any) will be determined.

3.4 Gas Protection Measures

Elevated carbon dioxide >5% (max value 6.5%) has been encountered in CP1-2 and WS203, with a maximum flow rate of 4.5l/hr indicating that Amber 1/CS2 ground gas protection measures will be required in the vicinity of these holes.

Based on these results it is recommended that Amber 1 / CS2 protection is required across the site.

Allowance for VOC resistance membrane and ventilated void is advised around former gasometer and WS207 until investigated further. This risk assessment should be updated following demolition and remediation of this area.

Site Area	Site Classification	Recommended Ground Gas Protection Measures
WS207 & Former Gasometer	Amber 1 / CS2 with hydrocarbon vapour resistant membrane	Low-level ground gas protection measures are required, using a hydrocarbon vapour resistant membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
Remainder of Site	Amber 1 / CS2	Low-level ground gas protection measures are required, using a membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as

		prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
--	--	--

A VOC membrane has been recommended until further investigation has been undertaken to confirm and also to follow best practice where limited guidance is available. SVOCS were encountered above the laboratories limit of detection however in very low concentrations. A ventilated void is proposed across site which is the primary protection and lifts the membrane away from direct contact with the ground (which removes the need for special membrane in regards to degradation due to contact). It is recommended that plots requiring VOC membranes are to be integrity tested on a 1:3 basis to demonstrate suitability & good workmanship.

Any plots which require ground gas protection measures will require ground gas protection validation reports. This will require an inspection by a qualified engineer and photographic evidence.

3.5 Construction / Maintenance Workers

In order to reduce potential risks associated with the determinants encountered on site, the following recommendations should be adhered to during site works:

- Any proposed site won/imported soils should be tested for contamination to ensure that they are suitable for the proposed end use as per Section 3.2
- Site workers should wear gloves, boots and overalls and wash their hands before eating, drinking and smoking. Excessive dust generation should be avoided. The site manager will inspect the risk assessments of the contractors on site/inspect on a regular basis to make sure this is upheld as per HSE / CDM guidance.
- Asbestos was encountered on site in one location (<0.001%). Vigilance should be adhered. If there is any suspected asbestos, a suitably qualified person should be notified and undertake appropriate sampling.
- It is recommended that during all excavations adequate ventilation should be maintained. If man entry is required, gas monitoring should be carried out as a precaution.
- Given the existence of Made Ground on the site it would be prudent to maintain vigilance during site clearance and construction, in case any areas of suspected contamination are encountered.
- If areas of suspected contamination are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.

A full discussion of the results of existing chemical analysis and the levels of contamination within these soils is included within the Pre-Tender Health and Safety File. The Contractor is aware of the presence of such soils and has therefore allowed for adequate Personal Protective Equipment to be provided on site.

It is recommended that full reference should be made to current guidance documents such as the HSE document "Protection of Workers and the General Public during the Redevelopment of Potentially Contaminated Land" HS (G) 66, HSE.

The results of all relevant chemical analysis will be provided to the relevant service providers in order to confirm any special precautions that may be required in respect of the installation of services and the protection of their workers.

3.6 Drinking Water Supplies

The use of Protect-a-Line is potentially required, therefore a pipeline assessment should be undertaken and confirmed with United Utilities once the pipeline layout has been confirmed. As the free product is proposed for removal in WS207, additional testing could be undertaken at pipeline depth once the remedial works have been undertaken to confirm if the need for protect a line is necessary.

3.7 Review of Conceptual Site Model

This conceptual model has been based on the investigation undertaken to date, however an additional phase of site investigation is required post demolition to fully assess the extent of the contamination across site.

There is at this stage a potential risk of unidentified contamination being present at the site. Should any suspicious material be encountered during the remediation works, the area will be investigated further by a Betts Geo Environmental engineer and sampled as necessary. The Contaminated Land Officer at the Local Authority will also be notified if the material is deemed to represent a risk to environmental receptors or public health. Samples will be forwarded to a UKAS accredited laboratory for a suite of analytical testing deemed appropriate based upon a visual and olfactory appraisal of the material identified. Once the results of any analysis are known, any further required remedial action (if any) will be determined.

The conceptual model will be updated if unforeseen contamination is found/on completion of the additional SI and as such the remedial measures recommended may change.

Target (Receptor)	Potential Source-Pathway Linkage	Remedial Action Required (where appropriate)	Est. Degree of Risk to Target Following Remedial Action Where Necessary
Site End Users	Inhalation of soil gases, odours or dust.	Removal of free product in WS207. Amber 1 / CS2 gas protection measures required across site. Allowance for VOC resistance membrane and ventilated void is advised in the area of former gasometer until investigated further. Radon protection measures are not required.	Low
Site End Users	Ingestion of, and skin contact with, contaminated soil.	Removal of free product in WS207. 600mm clean cover across the site (with the additional of a geotextile or hardcore break layer in north parcel) to gardens & 300mm clean cover to POS advised.	Low
Site End Users	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc	Removal of free product in WS207. 600mm clean cover across the site (with the additional of a geotextile or hardcore break layer in north parcel) to gardens & 300mm clean cover to POS advised.	Low
Construction/ Maintenance Workers	Inhalation of soil gases, odours or dust.	PPE, contaminated material handling techniques used. Asbestos has been found within Made Ground on site which was identified as Amosite loose fibres quantified to <0.001% (TP3). Appropriate PPE should be worn in affected areas and dampening down of asbestos containing soils should be undertaken for any machine traffic. Further risk assessment should be carried out. Asbestos is below 0.1% therefore is deemed to be suitable to remain on site overlain with a break layer and a clean cover system (subject to regulatory approval).	Low (assumed basic PPE is used)
Construction/ Maintenance Workers	Ingestion of, and skin contact with, contaminated soil	PPE, contaminated material handling techniques used.	Low (assumed basic PPE is used)

Plants	Adverse effects on growth caused by the presence of contaminants in soil	Removal of free product in WS207. 600mm clean cover across the site (with the additional of a geotextile or hardcore break layer in north parcel) to gardens & 300mm clean cover to POS advised.	Low
Buildings and Structures	The flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards	Removal of free product in WS207. Amber 1 / CS2 gas protection measures required across site. Allowance for VOC resistance membrane and ventilated void is advised in the area of former gasometer until investigated further. Radon protection measures are not required.	Low
Foundations	Sulphate attack of foundations	Foundations to be designed as per section 16.4 of Betts Geo SI report.	Low
Water Supplies	Hydrocarbons penetrating plastic water supply pipes.	UURA should be undertaken in order to confirm requirement for a barrier pipe, elevated hydrocarbons identified however WS207 will be remediated. Post remedial testing recommended once pipeline route known.	Low
Groundwater	Migration of soluble contaminants into groundwater on or off-site	Removal of free product in WS207. Site is underlain by generally impervious cohesive strata and vertical migration is considered unlikely. Therefore, the risk is generally deemed as LOW once hotspot has been removed.	Low
Surface Water	Migration of soluble contaminants and/or direct run-off of contaminants	No surface water features identified onsite or within 500m of site.	Low

4 SITE PREPARATION AND ENABLING WORKS

4.1 Site Set-up, Organisation and Safety

Site works will be supervised during any delineation and removal of contaminated materials by a suitably qualified Engineer, who will report to the Project Manager.

Site cabins and welfare facilities are to be established at a location to be agreed with the Engineer. All welfare facilities must be established in accordance with the relevant health & safety statutory requirements. Provision shall be provided on site for car parking for all site employees.

All site personnel will undergo a site-specific health and safety induction prior to commencement of work on site.

The Engineer will be informed prior to any proposed entry of a confined space or deep excavation. Entry must be restricted to suitably qualified and equipped personnel.

Works will be carried out with proper regard to current statutory requirements.

During the remediation works, all personnel on site will comply with guidance provided in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land". In summary, the following shall be provided:

- Protective clothing, footwear and gloves (Personnel should be instructed in why and how they are to be used).
- Hand-washing and boot-washing facilities.
- Smoking shall be limited to designated areas.

If at any time during the works, personnel begin to feel unwell, they are to inform the Engineer or Site Manager, who will determine appropriate action.

All visitors to site must enter and register at the main Site Office.

4.1.1 Responsibilities

Prior to the commencement of any works, in agreement with the Engineer, The Client will:

- Establish the boundaries of the site and the working areas.
- Undertake a dilapidation survey of site boundaries, adjacent properties and highways, via dated photographs or video footage.
- Liaise with the Local Authority regarding working hours, noise\dust\odour control, and protected trees.
- Liaise with the Local Water Company regarding any proposed discharge to sewer.
- Complete a full services search and liaise with all relevant utility companies regarding work in close proximity to their apparatus
- Inform the Engineer of any risk, identified and assessed, which could impact upon the Engineer's activities.
- Prepare the necessary COSHH statements and Health & Safety Plan in accordance with CDM regulations.

The contractor will ensure that:

- Secure the full site boundary (if necessary, provide and erect herras-type fence to protect members of the public from the works).
- Personnel, plant, materials and other equipment related to the contract are confined within the boundaries of the site.
- Any live services lying within the site boundary are marked and protected, or appropriate arrangements

made to truncate them.

- Good practices relating to personal hygiene are adopted.
- Suitable precautions are implemented at all times to prevent off-site migration of pollutants via airborne dust and vapours.
- Suitable precautions are taken to prevent the spread of mud and debris on public highways.
- Refuelling of mobile plant is undertaken in a designated area. Above ground oil storage tanks shall comply with the requirements of Pollution Prevention Guideline PPG2. A spill kit shall be kept on site, adjacent to the designated refuelling area.

4.1.2 Engineering Supervision and Validation

The responsibilities of the Engineer shall include, but not be limited to, the following:

- Ensuring that all site personnel are suitably qualified and given an appropriate induction at the beginning of their first day.
- Supervision of the remedial and ground preparatory works by a competent and independent consultancy.
- Advice on the correct handling of materials and conditions encountered.
- Guidance on the appropriate protective clothing and safety equipment that is to be made available and used.
- Ensuring that personal hygiene arrangements are adequate.
- Retrieval of soil and water samples and the subsequent scheduling of appropriate laboratory analysis to enable validation of various aspects of the works, and to advise the Project Manager of progress
- Liaison with statutory authorities as required.

The Engineer will maintain records of the works to include the following:

- Daily record sheets to include a summary of the day's activities.
- Date and weather conditions.
- Plant, personnel and visitors present.
- Aspects relating to Health and Safety, Environmental Control, or non-compliance with this RS.
- Site surveys as necessary to record the locations of demolition, excavation and filling activity.
- Test results.

On satisfactory completion of all the works the Engineer will prepare a Validation Report. Copies of the Validation Report will be issued to the Client and the Local Authority.

The Validation Report will stand as certification that the ground preparatory works (and remediation works if appropriate) have been carried out in accordance with this Remediation Strategy.

The **Validation Report** will include:

- A summary of the preparatory & remedial works undertaken, including any works associated with unforeseen ground conditions.
- Geotechnical test results associated with ground improvement or re-engineering beneath proposed highways and buildings.
- Copies of any correspondence with Regulators relating to specific aspects of the remedial works.
- Waste transfer notes are to be provided as part of the validation report to show an audit trail of where soil has been deposited.

For reasons of practicality, detailed daily records prepared by the Engineer during the works will not be appended to the Validation Report, but copies can be viewed at Betts offices if required.

The above recommendations will take account of the actual remedial works undertaken and may differ significantly from recommendations originally presented in the site investigation report and remedial strategy.

4.2 Site Clearance

Site clearance will be required, as areas of hard standing are present on site. Hardstanding areas will need to be excavated and placed within less sensitive areas, such as areas of public open space and roadways. Any trees, bushes and shrubs that are required to be removed as part of the redevelopment of the site will be undertaken.

Dense vegetation is present in some areas of site. Any vegetation/trees present will require clearing with all root balls removed and chipped before removal off site. It is suggested that the chippings could be sent to a biomass plant for reuse.

4.3 Excavation of Hardstanding and Foundations

Concrete hardstanding should be broken out and excavated and placed in a stockpile. It is anticipated that concrete arisings are suitable for re-use below proposed car parking areas or highways once they have been crushed.

Tarmac hardstanding (and tarmac containing Made Ground) contains hydrocarbon compounds which are potentially contaminating. Tarmac should be lifted and placed in a stockpile separate from other arisings in order to avoid contamination. It is anticipated that tarmac arisings are suitable for re-use below proposed car parking areas or highways once they have been crushed.

It is anticipated that all the foundations/obstructions encountered during the ground investigation will be broken out. Where obstructions exist they will be chased to full depth wherever possible. If this proves not possible in agreement with the engineer the location will be surveyed in by the contractor as part of the as built plan.

Given that the underlying natural clays (although at depth) are likely to be deemed chemically suitable, it may be possible to re-use foundation arisings as subsoil within garden areas. Foundation arisings will need to be carefully managed to not contaminate natural soils with the overlying made ground, arisings should be segregated as they are dug out of foundation trenches/roadways etc. Arisings are physically different and as such should be able to be segregated accordingly. Subsoils will be physically assessed upon placement within garden areas, should any suspected made ground be encountered within the subsoil material placed then additional chemical validation will be required to confirm the suitability of the material placed.

Any material that is deemed to be unsuitable for crushing and re-use will be removed from the site to licensed landfill.

Any areas of free product that are identified will be removed and disposed of at a suitably licensed facility.

A Materials Management Plan is to be put in place by both the contractor and developer to ensure soils are not deemed as waste / landfill and subject to HMRC taxes or fines.

4.4 Excavation of Footings

Heavy plant is generally operated between the hours of 8:00am and 6:00pm Monday to Friday, 8:00am and 1:00 pm Saturday, depending on light levels.

Noise levels will generally be less than the 80 – 85 dB range, with occasional breaches in excess of 85 db. Periods of noise generation in excess of 85 dB are anticipated as being during the initial enabling works and slab removal stage and thereafter for short periods. All construction plant will be selected from well maintained and silenced stock.

Site vigilance for unforeseen hotspots will be undertaken with the method of dealing with unforeseen briefed to site management.

4.5 Arisings

Site space is likely to be limited, however wherever possible, retention of arisings for reuse on site will be made. Foundation arisings of natural strata may be deemed chemically suitable for clean cover system and may be feasible to use in the lower capping layers. Chemical testing will be required.

Any material that is deemed to be unsuitable for re-use will be removed from the site to licensed landfill.

4.6 Dust, Vapour & Odour Control

The excavation of fill should not present a significant problem with regard to emission of dust during excavation. Nonetheless, the monitoring and mitigation measures outlined below may be required if dust, vapour or odour are noticeable.

Presence of asbestos fibres within the Made Ground means damping down during the excavation of Made Ground is recommended to suppress the release of asbestos fibres.

4.7 Odour Monitoring

If necessary, olfactory monitoring for odour nuisance will be undertaken at the site boundary down-wind of the excavation area during all excavation works. Odour monitoring will be carried out at these locations no less than three times a day during active site works.

At each monitoring event, the odour level will be subjectively classified as none, slight, moderate, or high, where:

- a slight odour level is detectable but not particularly noticeable,
- a moderate odour level is noticeable but not offensive, and
- a high odour level is offensive.

If high odour levels are detected in the same location on more than two occasions during any three-day period, then one or more of the actions outlined Sections 5.7.3 below will be undertaken in order to reduce the odour levels.

The below trigger levels are noted for health and safety reasons, not for the protection of human health off the site boundary. If odours are noted to be present for any duration, then they will be assessed by a Geo-Environmental Engineer with samples taken from the odour source (if identified). If elevated determinants are found then toxicological human health exposure limits may be more applicable.

4.8 Trigger Levels

Proposed action limits for requiring respirator protection in the vicinity of the excavations and for taking corrective action to mitigate against the generation of air-borne dust or volatile organic contamination are outlined below. They are based on EH40/2002, Occupational Exposure Limits, Health and Safety Executive. EH40 trigger levels for total VOCs and dust are:

VOC & Dust Trigger Levels

Determinand	Long-Term Exposure Limit (8 hour time-weighted average)	Short-term Exposure Limit (15 minute reference period)
Total VOCs	1 ppm	3 ppm
Dust	4 mg/m ³	12 mg/m ³

The long-term exposure limit for total VOCs is based on the EH40/2005 long-term exposure limit (8-hour time-weighted average) for benzene. The short-term exposure limit is set at three times the long-term exposure limit as recommended in EH40/2002.0

The long-term exposure limit for dust is based on the EH40/2005 long-term exposure limit (8-hour time-weighted average) for respirable dust, which is taken from the General COSHH Approved Code of Practice, 1997. Again, the short-term exposure limit is set at three times the long-term exposure limit.

4.9 Mitigation

At all times during the excavation works, Best Practicable Means shall be employed to minimise dust, odour and VOC generation and their emission off site.

If dust or VOC concentrations in air exceed the long-term trigger levels in the vicinity of the excavation area, but are below the long-term trigger levels at the site boundary, then respirator protection will be required for all site personnel working in the excavation area.

Respiratory protection that conforms to the European Product Directive (CE) shall be readily available for personnel exposed to odours. Twin cartridge respirators, that conform to EN140, fitted with class A1 filters cartridges, which conform to EN141 (organic gases and vapours), shall be used. If highly odorous material is encountered on site then masks with Class A2 filters shall be used.

In addition, one or more of the following corrective actions to mitigate against the generation of air-borne dust or volatile organic contamination will immediately commence:

- Mist and water spraying to eliminate dust and/or reduce generation of volatile compounds.
- Reduction of the exposed active excavation area by backfilling or covering to reduce the generation of volatile compounds.

If dust or VOC concentrations in air exceed the long-term trigger levels at the site boundary then excavation activities will be stopped immediately and one or more of the above corrective actions will commence. Work will not begin again until the air quality at the site boundary has returned to an acceptable level and only after all reasonable actions have been taken to prevent the air quality at the site boundary from again declining to an unacceptable level.

4.10 Export to Landfill

Any material exported from site to landfill will be hauled by a registered waste carrier in accordance with the requirements of the Duty of Care Regulations, 1991 and the Landfill (England & Wales) Regulations 2002.

A transfer note shall be completed, signed and retained by the parties involved. The transfer note shall include the volume of waste, the nature of the material and a statement of its chemical composition, details of the source and destination sites, and details of the haulier.

In order to protect the general public from dust, wagons that are to be used for the haulage of the contaminated material from the site will be sheeted. In addition, the Contractor must ensure that no fluids seep from the wagons.

In order to provide the landfill facility with information regarding chemical composition of the waste, analysis results from the ground investigation and the desk study will be supplied to the site prior to removal for classification.

As of 16th July 2005 the Waste Acceptance Criteria of the Landfill Regulations 2002 were fully implemented, which will result in the enforcement of a more stringent approach to waste assessment and its disposal to landfill.

All hazardous waste going for disposal at landfills must be classified according to the new European Waste Catalogue (EWC).

Contaminated soils are "Mirror entries" in the EWC. Waste contaminated soils may be classified as either *hazardous* or non-hazardous depending on the concentrations of "dangerous substances" in the waste soil. An assessment of the composition of the waste soil will therefore be undertaken to determine if it is hazardous waste.

The WAC set threshold concentrations for leachable components of the waste stream and landfill operators will have waste acceptance procedures in place to ensure that only compliant waste is landfilled. Most waste will need to be treated before it can be landfilled to reduce its quantity and the hazard it presents. Leaching compliance testing will be required in accordance with BS EN 12457-3:2002.

In addition, the site will be operating under a Site Waste Management Plan recording both import and export of materials.

4.11 Backfill of Excavations

Excavations (to remove relict structures, contamination etc) are to be "surveyed in" and backfilled as necessary to achieve the desired levels, with suitable materials and subjected to compaction specification, to be agreed with the Engineer.

However, where an excavation conflicts with the footprint of a proposed adopted highway, compaction in accordance with the Specification for Highway Works Table 6/1 will be undertaken.

4.12 Boundary Issues

The Client's Designer should ensure that proposed levels tie in with the surrounding infrastructure, and ground levels of adjacent properties.

4.13 Highways

The contractor will agree acceptable performance criteria, and an appropriate Specification for any necessary ground improvement, with the Client and the adopting authority where necessary.

The Contractor will arrange for the necessary compliance testing to be undertaken at formation level on road alignments, as required by the adopting authority and Engineer.

4.14 Protection of Buried Concrete

It is considered for concrete design purposes that brownfield site and static groundwater conditions are applicable.

Concrete Classification	
Design Sulphate Class	DS-1
ACEC Class	AC-1s

4.15 Control of Groundwater

Groundwater control measures are likely to be required for all excavations within the Made Ground due to perched water encountered during the fieldwork.

Hydrocarbons have been identified in one location on site, however, this source of contamination is proposed to be treated/removed off site before any further remedial works commence, lowering any risk to underlying groundwaters.

No limiting values are proposed, but the Contractor shall comply with best practice as outlined below.

The Contractor shall make all necessary arrangements to prevent off-site migration of contaminated sediment via surface water run-off and avoid any pollution of the adjacent watercourse. This will necessitate the installation of surface water grips, and removal, sealing-off, or diversion of all redundant former site drains (and any land drains).

A Silt Management Plan shall be prepared by the Contractor, describing the mitigation measures that will be put in place to intercept direct run-off from any disturbed areas, stockpiles etc, thereby preventing any potential impact of adjacent land and nearby watercourses. Surface water run-off will probably require treatment (as a minimum to allow settlement of fines) prior to consented discharge.

Perched waters encountered during the earthworks, and / or water associated with redundant drains and buried structures, may be contaminated with hydrocarbons and/or VOCs. Any potentially contaminated water should not be allowed to escape to other areas until the results of the analysis are available and, if required, a suitable means of water treatment has been agreed.

Water collected in sumps should be passed through a series of oil/water separators to remove any oily contamination. Oils trapped in the absorbent medium shall be disposed of to a suitably licensed landfill site.

Treated water shall then be tankered off-site, or be discharged to sewer, subject to analytical results and local water treatment company consent.

Groundwater levels may vary from those at the time of the investigation, for example in response to seasonal

fluctuations.

4.16 Contingency for Unknown

There is at this stage a potential risk of localised, unidentified contaminated Made Ground being present at the site.

Should any suspicious material be encountered during the remediation works, the area will be investigated further by a Betts Geo Environmental engineer and sampled as necessary. The Contaminated Land Officer at the Local Authority will also be notified if the material is deemed to represent a risk to environmental receptors or public health. Samples will be forwarded to a UKAS accredited laboratory for a suite of analytical testing deemed appropriate based upon a visual and olfactory appraisal of the material identified.

Once the results of any analysis are known, the required remedial action (if any) will be determined.

4.17 Site Certification

Once the remediation works have been undertaken, a 'completion' report (as described in Section 4.1.1 of this report) will be prepared. This will comprise relevant site records and stand as certification that the appropriate remediation works have been carried out in accordance with the agreed redevelopment strategy. Reports will be submitted to the Local Authority for their approval, thereby enabling the release of the site for subsequent development.

4.18 Betts Note

This Remediation Strategy have been based on the investigation undertaken to date, however an additional phase of site investigation is required post demolition to fully assess the extent of the contamination across site.

Findings of the Coal Investigation should be presented to the Coal Authority for their agreement.

5 REMEDIATION HOLD POINTS

Pre-Construction Phase	Liaison with relevant statutory bodies (LA/CA/EA) for approval of initial remedial requirements. Demolition of the existing buildings concurrent with the delineation / Removal of Free Product in WS207 Additional investigation across site once demolition of existing buildings Any further remediation required following the post demo SI including additional Regulatory Correspondence. UU Pipeline RA required post demo
Construction Phase	Clean and inert capping installation and verification. Installation of ground gas protection measures and verification. Subject to additional remediation requirements

Notes on Limitations

This report does not consider ecological impacts (e.g. bats) or botanical risks (e.g. Japanese knotweed). It is recommended that these are considered as part of the assessment of development constraints for the site.

The assessment and judgements given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. The data essentially comprised a study of available documented information from various sources (including Client Furnished reports) together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information. Actual risks can only be assessed following a physical investigation of the site.

The site investigation has been carried out to provide information concerning the type and degree of contamination, and ground and groundwater conditions to allow a reasonable risk assessment to be made. Betts Geo Environmental Ltd undertake to exercise all reasonable skill, care and due diligence in the exercise of the investigation with respect to sampling techniques, sample storage and report interpretation.

The assessments and judgement given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. Data acquisition is subject to the limitations of the methods of investigation used. Exploratory holes undertaken during fieldwork investigate small a small volume of ground in relation to the size of the site and as such can only provide an indication of site conditions. There may be conditions pertaining to the site and the proposed development i.e. localised "hotspots" of contamination, which have not been disclosed by the investigations.

The findings and opinions are relevant to the dates of our site works and should not be relied upon to represent conditions at substantially later dates. Conditions at the site will change over time due to natural variations and anthropogenic activities. Groundwater, surface water and soil gas conditions should be anticipated to change with diurnal, seasonal and meteorological variations.

The opinions expressed in this report regarding any contamination are based on simple statistical analysis and comparison with available guidance values. No liability can be accepted for the retrospective effects of any changes or amendments to these values.

This report was prepared by Betts Geo Environmental Ltd for the sole and exclusive use of the client. In response to particular instructions, any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

This document has been prepared for the titled project only and should any third party wish to use or rely upon the contents of the report, written approval from Betts Geo Environmental Ltd must be sought.

Betts Geo Environmental Ltd accepts no responsibility or liability

- a) for the consequences of this document being used for the purpose other than that for which it was commissioned
- b) and for this document to any other party other than the person by whom it was commissioned.