

Your Housing Group

REMEDIATION STRATEGY

for

Edge Lane, Openshaw

May 2020

REPORT No: 19YHG001/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

DOCUMENT ISSUE RECORD

Contract No: 19YHG001

Client: Your Housing Group

Contract: Edge Lane, Openshaw

Document: Remediation Strategy

Prepared by:



K Rodway

Checked by:



M Fawcett

Authorised by:



M Fawcett

Date:

May 2020

REVISION RECORD

Revision	Date	Description	Prepared by
0	May 2020	Draft for comment	KR
A	June 2020	Additional remedial actions added	KR
B	August 2020	Additional remedial actions added	KR
C	May 2021	Comments from EHO and additional delineation work	KR
D	Dec 2021	Addition of plot no for gas protection measures	KR

TABLE OF CONTENTS

1.	INTRODUCTION	5
	The Commission and Brief	5
2	Background	7
2.1	Site Description	7
2.2	Site History	7
2.3	Hydrogeology and Hydrology	8
2.4	Geology	8
2.5	Summary of Ground Investigation – Wardell Armstrong (WA)	9
2.6	Summary of Ground Investigation – Betts Geo (BG)	10
	Ground Gas Protection Measures	15
3	REMEDIAL ACTIONS	19
3.1	General	19
3.2	Delineation and Remediation of Hotspot TP104 (Pre-Construction) (Area A) ...	20
3.3	Further Investigation and Delineation of Basement Boiler House (Pre-Construction)	22
3.4	Investigation into Former Pond Area (Pre-Construction)	24
3.5	Machine Pit Investigation (Pre-Construction)	25
3.6	Possible Asbestos Containing Material Stockpile (Pre-Construction)	26
3.7	Hydraulic Test Bay / Boiler House (Area B) and Sump Soil Sampling (Area C)	28
3.8	Area D Delineation	33
3.9	Basements / Air Raid Shelters on Western Boundary (Area E)	33
3.10	Area F Delineation	34
3.11	Japanese Knotweed (JKW) Excavation and Burial (Area G)	35
3.12	Perched Water Sampling	36
3.13	Deep Obstructions and Piles	39
3.14	Areas of Deep Fill Unsuitable for Vibro Ground Treatment	39
3.15	Installation of Clean and Inert Capping (Construction Phase)	39
3.16	Site Won Soils	40
3.17	Imported Soils	41
3.18	Construction / Maintenance Workers	41
3.19	Drinking Water Supplies	42
3.20	Review of Conceptual Site Model	42
4	REMEDICATION STRATEGY	44
4.1	Aims	44
4.2	Remediation Scope	44
4.3	Remediation Methodology	45

5	REMEDIAL WORKS (CONSTRUCTION OBJECTIVES).....	2
5.1	Site Clearance	2
5.2	Reuse of Site Materials.....	2
5.3	Excavation of Hardstanding and Foundations.....	2
5.4	Arisings	2
5.5	Dust, Vapour & Odour Control	3
5.6	Odour Monitoring	3
5.7	Trigger Levels.....	3
5.8	Mitigation	4
5.9	Export to Landfill.....	4
5.10	Backfill of Excavations.....	5
5.11	Boundary Issues	5
5.12	Highways	5
6	METHODOLOGY / PROGRAMME	6
6.1	Imported Soil.....	6
6.2	Contingency for Unknown	7
6.4	Site Certification	7

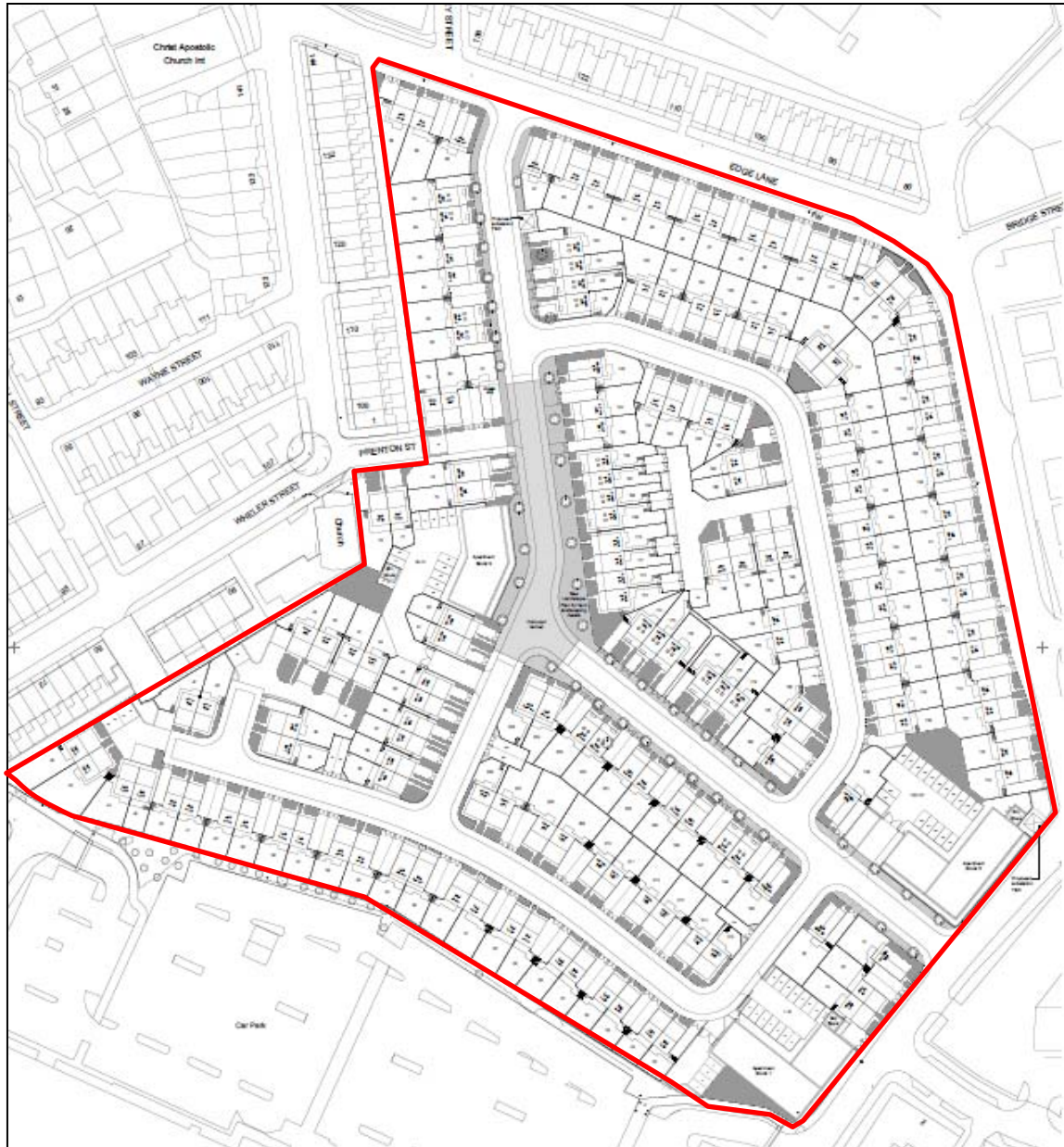
APPENDICES

Item.	Title
Drawing	Exploratory Hole Location Plan
Certificates	Laboratory Testing

1. INTRODUCTION

The Commission and Brief

Betts Geo Environmental (Betts) has been commissioned by Your Housing Group to prepare a Remediation Strategy for the remediation and preparatory works for their Edge Lane site in Openshaw, Manchester. The plan below shows the approximate site boundary;



Proposed Site Layout – Edge Lane, Openshaw – 12.12.19 (Drawing reference: 0723-EA-A-P002)

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

Your Housing Group provided Betts Geo with two previously undertaken reports for the site. These reports are as follows;

- Phase I Geo-Environmental Desk Study - Edge Lane, Openshaw, Ref; SH12240 RPT-003, Dated; October 2019, By; Wardell Armstrong, For; Chilton Estates Ltd.
- Site Investigation Report - Edge Lane, Openshaw, Ref; SH12240 RPT-001, Dated; February 2019, By; Wardell Armstrong, For; Chilton Estates Ltd.
- Ground Investigation Report - Edge Lane, Openshaw Ref. 19YHG001/GI, rev 1 dated August 2020 by Betts Geo for Your Housing Group.

It is understood that Your Housing Group has reliance on these reports. Where necessary the above reports have been used throughout this report and referenced accordingly. Whilst Betts Geo Environmental Ltd cannot be held liable for the third party, client furnished, results/data, it is suggested that it is reasonable to assume that the data provided in these reports have been undertaken with suitable care and due diligence by suitably experience consultants. As such the data is regarded as being of an appropriate standard to utilise within this report.

The following summary sections have been composed from the above reports.

2 Background

2.1 Site Description

The site is irregular in shape and can be accessed via the gate house along the eastern site boundary. The site is currently used for commercial use with a large warehouse located in the southern half of site, and a number of recently demolished buildings (to slab level – former slabs evident) to the north of site. A number of stockpiles of demo material are present in the location of the recently demolished buildings.

Asphalt car parking areas are located in the centre of site and to the south east of site. A grassed mounded area is present to the south west of site. Landscaping is also present along the very north of site.

The large warehouse is currently undergoing asbestos removal and is then planned for demolition and as such no access was possible at the time of investigation.

Site levels are stepped, with the north of the site being approximately 1.5 metres higher than the south. A brick retaining wall and asphalt ramp separates the two varying site levels in the centre of the site.

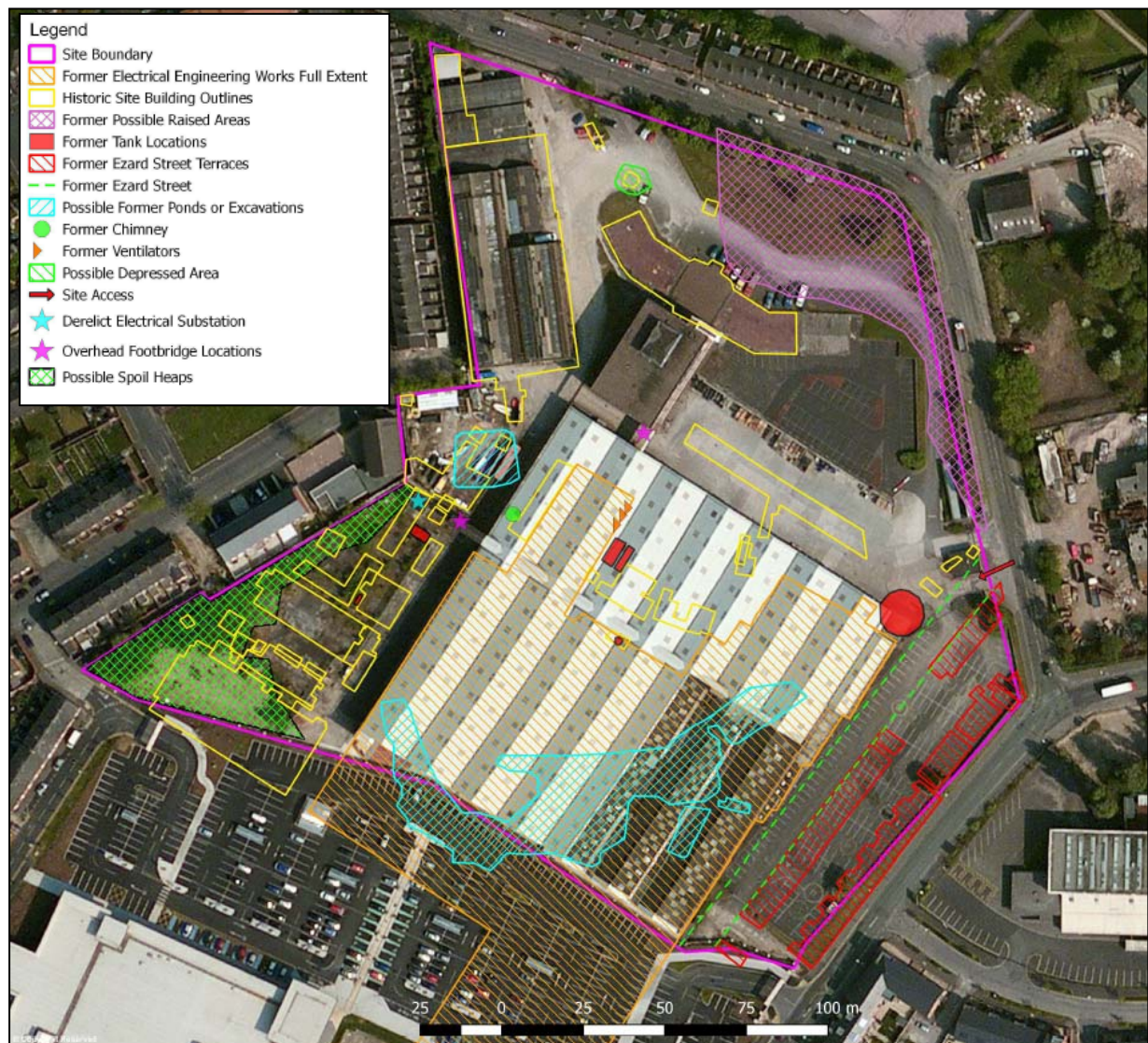
2.2 Site History

The earliest consulted map was the 1848 map which shows the site as an undeveloped area of fields with lanes. By 1894 some buildings are shown in the south of site along with two ponds in the centre and west of site, which is also surrounded with residential development by this time. 'Ezard Street' is also shown in the south east of site with terraced residential properties. By circa 1900 the ponds previously present are no longer shown assumed backfilled.

The 1932 map marks the development of site to an Electric Works in the south and sports ground in the north with a tramway in the north-east. Many other buildings associated with the works are shown in the centre north and west of site. By circa 1949 the sports ground and tramway are no longer shown and additional buildings are shown in the north of site with tanks and chimney. More buildings are shown in the north of site by 1958 including the main offices. During 1979-1981 more buildings are shown with extensions to existing and 'Ezard Street' is no longer shown.

By 1991 to present the site ceased to operate as an electrical works with the main warehouse in the south of site used to store homeware products with numerous buildings in the north of site demolished or derelict with extensive concrete hardstanding from yards and former building footprints. The main manufacturing processes undertaken within the electrical works buildings included: fabrication and assemble of switchgear units, welding, polyurethane coating, electrostatic painting and testing.

An overlay showing the historic site uses can be seen below;



2.3 Hydrogeology and Hydrology

The superficial deposits of the Till are designated as a Secondary Undifferentiated Aquifer overlying Secondary B and Principle Aquifers in the Manchester Marl and Collyhurst Sandstone formations respectively. It is noted that previous site investigations have encountered groundwater at 0.25 - 3.32mbgl. No surface water features are noted onsite with the Ashton Canal at 25 - 100m north being the closest. There are six ground water abstracts at 1-1.5km from site.

2.4 Geology

It is outlined that despite no made ground being recorded by the BGS, made ground will likely be present due to the sites development history at variable thickness across site, 2.5m depth of made ground is mentioned within the phase 1 report for the north portion of site.

The superficial geology of Devensian Till has been proven to a depth of circa 45mbgl to the south of site over the Manchester Marl Formation to circa 60mbgl over the Collyhurst Sandstone Formation proven to 100mbgl. The Collyhurst Sandstone Formation directly underlies the Till in the north and north east of site.

2.5 Summary of Ground Investigation – Wardell Armstrong (WA)

Wardell Armstrong undertook a Site Investigation on site in February 2019. A summary of the Site Investigation can be found below. Full details can be found in their report, as referenced in section 1.3.

2.5.1 Scope of Works

The Wardell Armstrong investigation was undertaken on the 20th and 21st December 2018 and comprised of the following;

- Ten (10 No.) window sample boreholes extending to between 4.00 and 5.00mbgl with three (3 No.) installed with gas monitoring wells (WS101, WS102 & WS105).
- Two (2 No.) manually excavated hand pits extending between 0.20 and 0.30mbgl.
- Two (2 No.) manually excavated soil samples extending between 0.20 and 0.30mbgl.

Exploratory holes were positioned in the west, north and south of site due to ongoing industrial land use in the east of site.

2.5.2 Ground Conditions

The following ground conditions were encountered;

- Made Ground was encountered in all exploratory hole locations (except for WS108 and WS109) from 0.0 to 2.5mbgl and comprised soft brown tinted light orange slightly clayey cobbly SAND with sandstone, brick, glass, clinker and concrete.
- Drift Deposits were encountered in all exploratory hole locations below made ground and was encountered from 0.4 – 5.0mbgl and generally comprised stiff to hard light brown slightly sandy slightly cobbly CLAY with thin bands of light brown tinted grey slightly cobbly clayey SAND encountered between 2.4 to 2.6mbgl.
- No groundwater was encountered during the site investigation.

2.5.3 Soil Contamination Encountered

Twenty-four (24 No.) soil samples were taken from the made ground and natural strata and analysed for metals, total petroleum hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAHs) and several other contaminants including asbestos. Eighteen (18 No.) samples were taken for total organic carbon (TOC) and six (6 No.) for VOCs and SVOCs. The results were screened against residential with plant uptake Generic Assessment Criteria (GAC) and the following elevated contaminants were found;

- Arsenic – WS101 (0.2-1.2mbgl)
- Lead – WS102 (0.2mbgl)

- WS104 (0.5mbgl)
 - HP101 (0.0-0.3mbgl)
- TPH (C16-C21) – WS101 (1.0mbgl)
- PAH – WS102 (0.2mbgl)
 - WS104 (0.5mbgl)
 - WS106 (0.2-0.4mbgl)
 - WS101 (0.2-1.2mbgl)
 - HP101 (0.0-0.3mbgl)
 - SS102
- Asbestos – WS104 (0.5mbgl)
 - WS106 (0.2-0.4mbgl)
 - WS101 (0.2-1.2mbgl)
 - HP101 (0.0-0.3mbgl)

2.5.4 Ground Gas & Groundwater

WS101, WS102 and WS105 were installed with ground gas and ground water monitoring standpipes, however no further information is given regarding the number of monitoring visits and no results are presented within the Wardell Armstrong Phase 2 report. Betts Geo has had confirmation from the client that no additional ground gas monitoring was undertaken on site.

2.5.5 Generic Quantitative Risk Assessment (WA)

It is discussed that the presence of the above elevated contaminants presents a human health hazard as the site is proposed to be redeveloped to residential housing. Remediation is likely to be required to effectively quell the risk.

Wardell Armstrong suggest that concentrations exceeding screening values should be managed/treated during demolition and remediation stages of the development in order to mitigate the risk to human health. No specific remedial recommendations are given.

2.6 Summary of Ground Investigation – Betts Geo (BG)

Wardell Armstrong undertook a Site Investigation on site in February 2019. A summary of the Site Investigation can be found below. Full details can be found in their report, as referenced in section 1.3.

2.6.1 Scope of Works

The Betts Geo investigation was undertaken in February 2020 and comprised of the following;

- Seventeen (17 No) machine excavated trial holes to between 1.10mbgl (TP109) and 2.80mbgl (TP117). These were targeted to areas of potential contamination including former garages, workshops, fuel tanks and basements as indicated on the plan in Section 3.2.1 above.
- Four (4 No) small diameter boreholes to depths of between 2.70mbgl (WS201) – 3.00mbgl

(WS202) and installed with ground gas and groundwater 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 (Metals, PAH's, TPH's) of thirty-nine (39 No) samples for heavy metals, TPH's, and PAH's.
- Analysis of thirty-nine (39 No) samples for asbestos analysis.
- Five (5 No) samples for geotechnical analysis.

TP113 could not be undertaken as this area was fenced off and in use as site cabins/site compound.

2.6.2 Ground Conditions

Made Ground

Various types of Made Ground were identified across site including concrete, tarmac, gravel of brick, black sand and gravel and reworked clay. The majority of the deeper Made Ground was encountered in areas of former buildings or pond.

The following pits encountered Made Ground where the base was not encountered;

- TP109 due to a concrete obstruction at 1.10mbgl
- TP112 was not bottomed out due to depth of Made Ground >2.70mbgl
- TP114 due to a concrete obstruction at 2.20mbgl.

Natural Strata

A stiff to very stiff dark brown slightly sandy slightly gravelly CLAY was encountered at depths of between 0.40mbgl (TP116) – 2.00mbgl (TP105). Occasional sand bands were noted within the clay in TP102 and TP115.

Groundwater - Fieldwork

Exploratory Hole	Depth (mbgl)	Strata	Remark
TP101	0.20 – 0.60	MADE GROUND	Slight seepages
TP102	0.35 0.35 – 0.90	MADE GROUND MADE GROUND	Slow groundwater ingress Seepages – arisings damp
TP103	0.70 – 1.10 1.30 – 2.30	MADE GROUND CLAY	Seepages.
TP104	0.30 – 0.80 1.10 – 1.80	MADE GROUND MADE GROUND	Slight seepages – arisings wet
TP105	0.55 – 0.90	MADE GROUND	Slight seepages
TP106	1.10 – 1.80	CLAY	Slight seepages in sand pockets
TP107	0.50 0.95 – 1.60	MADE GROUND MADE GROUND	Moderate groundwater ingress Moderate groundwater ingress with hydrocarbon sheen
TP108	0.10 – 0.65	MADE GROUND	Slight seepages
TP111	0.15 – 0.30 1.70	MADE GROUND CLAY	Slight seepages Occasional sand horizons with running sands
TP112	0.50 – 0.70 1.70 – 2.70	MADE GROUND MADE GROUND	Seepages with wet arisings

Exploratory Hole	Depth (mbgl)	Strata	Remark
TP115	0.20 – 0.35 1.00 – 2.70	MADE GROUND CLAY	Slight seepages Arisings wet within sand bands.
TP117	1.15 – 1.50	MADE GROUND	Slight seepages
TP118	0.10 – 0.45 0.45 – 0.90	MADE GROUND MADE GROUND	Slight seepages

2.6.3 Soil Contamination Encountered

Topsoil

No topsoil was encountered on site therefore no testing was undertaken on this strata.

Made Ground

The following determinants exceeded the residential with homegrown produce guidance levels within the Made Ground:

Heavy Metals

Determinants	Location	Depth (mbgl)	Concentration (mg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
Arsenic	TP102, TP106, TP108, TP112, TP117	0.50 – 1.80	39 - 139	32	37
Lead	TP102, TP104, TP106, TP108, TP109, TP112, TP114, TP117	0.20 – 1.80	234 - 2280	-	200

PAH's

Determinants	Location	Depth (mbgl)	Concentration (mg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
Benzo(a)anthracene	TP104, TP105, TP112, TP118	0.40 – 1.00	8.93 - 49	8.54 (6% SOM)	-
Benzo(a)pyrene	TP104, TP105, TP112, TP118	0.40 – 1.00	6.64 – 30.5	2.06 (6% SOM)	4.95
Benzo(b)fluoranthene	TP104, TP105, TP112	0.40 – 1.00	15.3 – 35.2	9.86 (6% SOM)	-
Dibenzo(ah)anthracene	TP104, TP105, TP112	0.40 – 1.00	1.47 – 3.43	1 (6% SOM)	-
Indeno(123-cd)pyrene	TP104	0.40	12.2	9.75 (6% SOM)	-
Naphthalene	TP104, TP118	0.40 – 0.75	13.5 – 68.3	12.2 (6% SOM)	-

TPH's

Determinants	Location	Depth (mbgl)	Concentration (mg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
Aro >C8 – C10	TP116	0.30	37	20.5 (1% SOM)	-
Aro >C10 – C12	TP104	0.40	472	468 (6% SOM)	-

Aro >C12 – C16	TP104	0.40	1560	830 (6% SOM)	-
Aro >C16 – C21	TP104, TP105, TP112	0.40 – 1.00	600 - 3460	1040 (6% SOM)	-
Aro >C21 – C35	TP104, TP105, TP112	0.40 – 1.00	2460 - 5990	1710 (6% SOM)	-

Asbestos

Seven (7 No) out of thirty nine (39 No) samples returned positive asbestos identification (all within the Made Ground). These samples are detailed below;

- TP102 @ 0.50mbgl - Loose Fibres of Chrysotile – <0.001%
- TP105 @ 0.65mbgl - Loose Fibres of Chrysotile – 0.006%
- TP108 @ 0.50mbgl – Loose Fibres of Chrysotile – 0.002%
- TP112 @ 1.00mbgl - Loose Fibres of Chrysotile – 0.004%
- TP114 @ 0.35mbgl - Loose Fibres of Chrysotile – <0.001%
- TP114 @ 1.50mbgl - Loose Fibres of Crocidolite – <0.001%
- TP115 @ 0.40mbgl - Loose Fibres of Amosite – <0.001%

Natural Strata

All determinants for heavy metals, TPH's and PAH's fell below the residential home grown produce guidance levels within the Natural Strata.

2.6.4 Generic Quantitative Risk Assessment and Conceptual Model (BG)

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.	Ground gas monitoring ongoing in one area – currently no specialist measures required based on findings – possible VOC Hydrocarbon risk – to be further assessed during remediation phase with PID screening	Low
Site End Users	Ingestion of, and skin contact with, contaminated soil.	Dependent on site levels – either 600mm with no dig layer if made ground is to remain on site. 300mm if made ground is to be removed as part of groundworks.	Low
Site End Users	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc	Dependent on site levels – either 600mm with no dig layer if made ground is to remain on site. 300mm if made ground is to be removed as part of groundworks.	Low
Construction/ Maintenance Workers	Inhalation of soil gases, odours or dust.	PPE	Low (assumed basic PPE is used)
Construction/ Maintenance Workers	Ingestion of, and skin contact with, contaminated soil	PPE	Low (assumed basic PPE is used)

Plants	Adverse effects on growth caused by presence of contaminants in soil	Dependent on site levels – either 600mm with no dig layer if made ground is to remain on site. 300mm if made ground is to be removed as part of groundworks.	Low
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards	Ground gas monitoring completed – currently no specialist measures required based on findings – possible VOC Hydrocarbon risk – to be further assessed during remediation phase with PID screening to hotspots	Low
Foundations	Sulphate attack of foundations	Foundations to be designed as per section 17.4.	Low
Water Supplies	Hydrocarbons penetrating plastic water supply pipes.	United Utilities pipeline risk assessment required.	Low
Groundwater	Migration of soluble contaminants into groundwater on or off site	No remedial action required.	Low
Surface Water	Migration of soluble contaminants and/or direct run-off of contaminants	No remedial action required.	Low

2.6.5 Betts Conclusion

Site End Users

Elevated determinants were encountered across the site within made ground, however TP104 can be deemed as a hotspot. As the hotspot areas identified during the Betts Geo investigation were targeted, site vigilance would be prudent during earthworks/remediation. If further areas are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.

Due to the amount of chemical testing undertaken across site, the extent of the contaminated made ground can be estimated. As a result and depending on proposed ground works (due to the sites current stepped levels), it may be possible to remove the made ground material from site where it is shallow to allow a cover system of 300mm (150mm topsoil/150mm subsoil).

If site levels allow, the contaminated materials could be retained on site, but below the clean and inert capping layer.

This will be reviewed once proposed site levels are known.

If the made ground is to remain on site (most likely), a 600mm cover system (150mm topsoil/450mm subsoil) with a geotextile no dig membrane at the bottom will be required to protect site end users.

Ground Gas Protection Measures

Gas monitoring is complete, the full results can be seen below;

Borehole Number	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Atmospheric Pressure (mB)	Peak Flow (l/hr)	Max GSV (CH ₄)	Max GSV (CO ₂)
WS201	0.0 – 0.1	0.0 – 0.1	19.0 – 21.0	1011 – 1025	0.1	0.000	0.000
WS202	0.0 – 0.1	0.0 – 0.8	19.1 – 21.0	989 – 1025	0.1	0.000	0.001
WS203	0.0	0.1 – 0.8	19.3 – 21.0	989 – 1025	0.1	0.000	0.001
WS204	0.0	0.0 – 1.0	19.1 – 21.3	989 – 1025	0.2	0.000	0.002
WS301	<0.1	0.0 – 0.3	20.8 – 21.0	1002 - 1005	0.1	0.000	0.0003
WS302	<0.1	0.0 – 0.1	20.9 – 21.0	1002 - 1005	0.2	0.000	0.0001
WS303	0.1	0.0 – 1.4	20.4 – 21.1	1002 - 1005	0.2	0.000	0.0014
WS304	0.1	1.0 – 1.8	16.1 – 17.9	1002 - 1005	0.1	0.000	0.0018
WS305	0.1	0.1 – 1.2	19.2 – 20.6	1002 - 1005	0.1	0.000	0.0012
WS306	FLOODED – Water too high to monitor						

Guidance

Three recent publications are used for ground gas risk assessment:

- 'Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present', Report Edition No.04 March 2007 NHBC – designed for use with low rise residential properties.
- CIRIA C665 'Assessing risks posed by hazardous ground gases for buildings' 2007 – high rise residential/flats.
- BS8485:2015 'Code of practice for the characterization and remediation from ground gas in affected developments.'

Further details/accompanying notes for the following gas risk assessments are enclosed in Appendix I. The proposed development at the site is private residential two-storey houses, therefore assessments using the NHBC guidance are deemed most appropriate.

Ground Gas Summary

Betts Geo has had confirmation from the client that no additional ground gas monitoring was undertaken on site as part of the Wardell Armstrong site investigation.

Following the completion of the Betts gas monitoring programme no elevated gas concentrations of gas screening values have been identified indicating that the investigated area of site is classified as Green/CS1. However, Due to the naphthalene and TPH levels encountered during the ground investigation, a hydrocarbon resistant membrane may be required in proposed dwellings located in the vicinity of TP104, TP105, TP112, TP116 and TP118.

The assessment is shown below;

Site Area	Site Classification	Recommended Ground Gas Protection Measures
Majority of site	Green	No specialist ground gas protection is required.
Specific areas – as shown on drawings	Amber 1	Hydrocarbon VOC resistant membrane required in specific site areas.

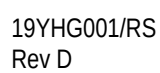
During earthworks, additional PID screening and testing for SVOC / VOC TPH and PAH was undertaken. PID screening results ranged from 0.1 to 0.7 ppm.

Whilst the PID showed negligible results some previously targeted investigation / hotspots still identified elevated occurrences.

Whilst there is little guidance for the determinants it is deemed prudent on a nuisance level that a HC / VOC membrane is installed along with a ventilated void. These are shown on the below sketches below, for completeness these areas cover plots:

- 82-87 and 201-204





3 REMEDIAL ACTIONS

All remedial works are to be completed under the supervision of an independent and suitably qualified consultant.

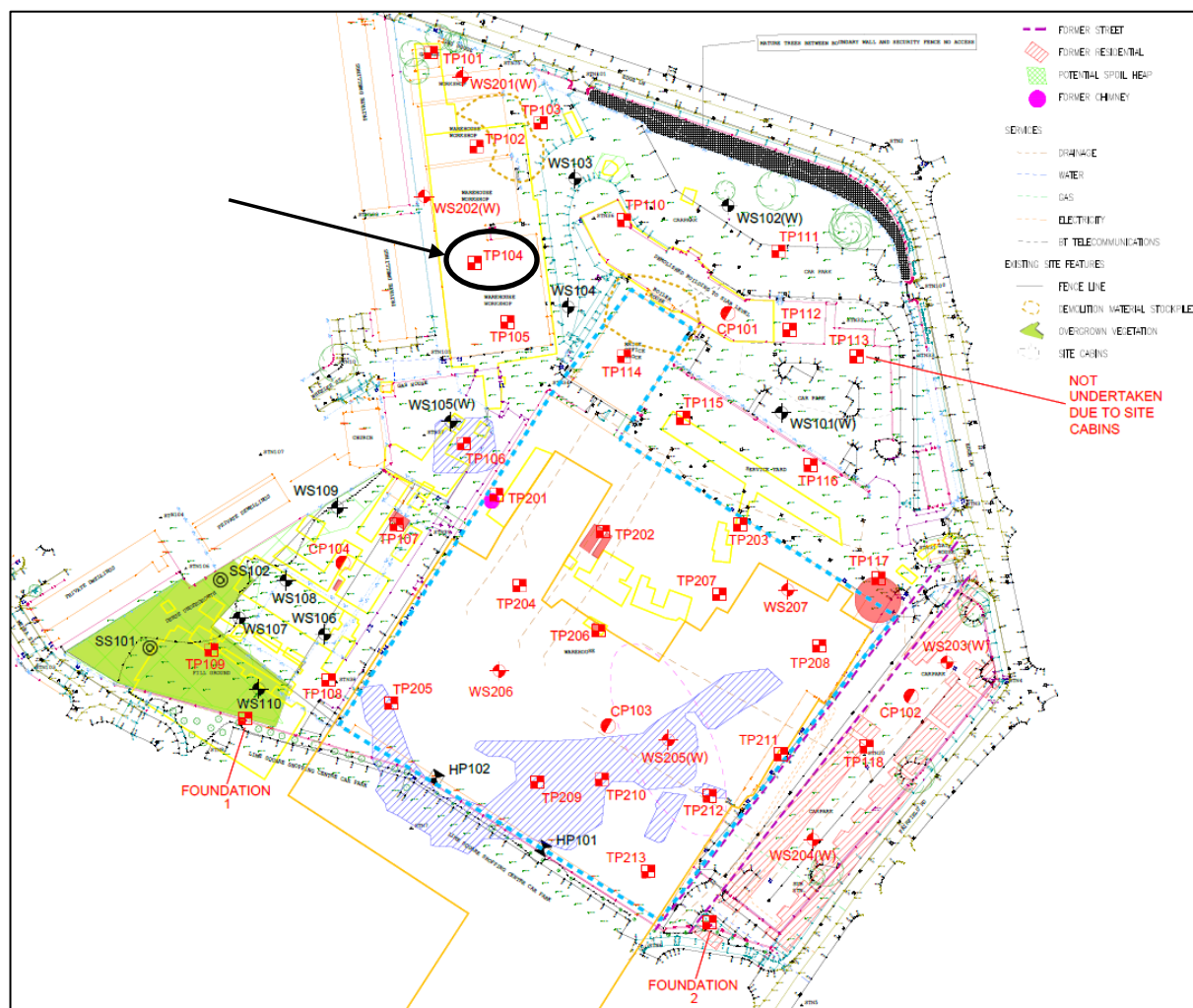
3.1 General

For ease of use, the remaining areas for remediation after the issue of the intrusive investigation report (19YHG001/GI/Rev1) were numbered as per the below sketch to aid in identification and description between site and office staff;



3.2 Delineation and Remediation of Hotspot TP104 (Pre-Construction) (Area A)

A TPH, PAH and Lead hotspot was recorded in the vicinity of TP104, as shown on the plan below;



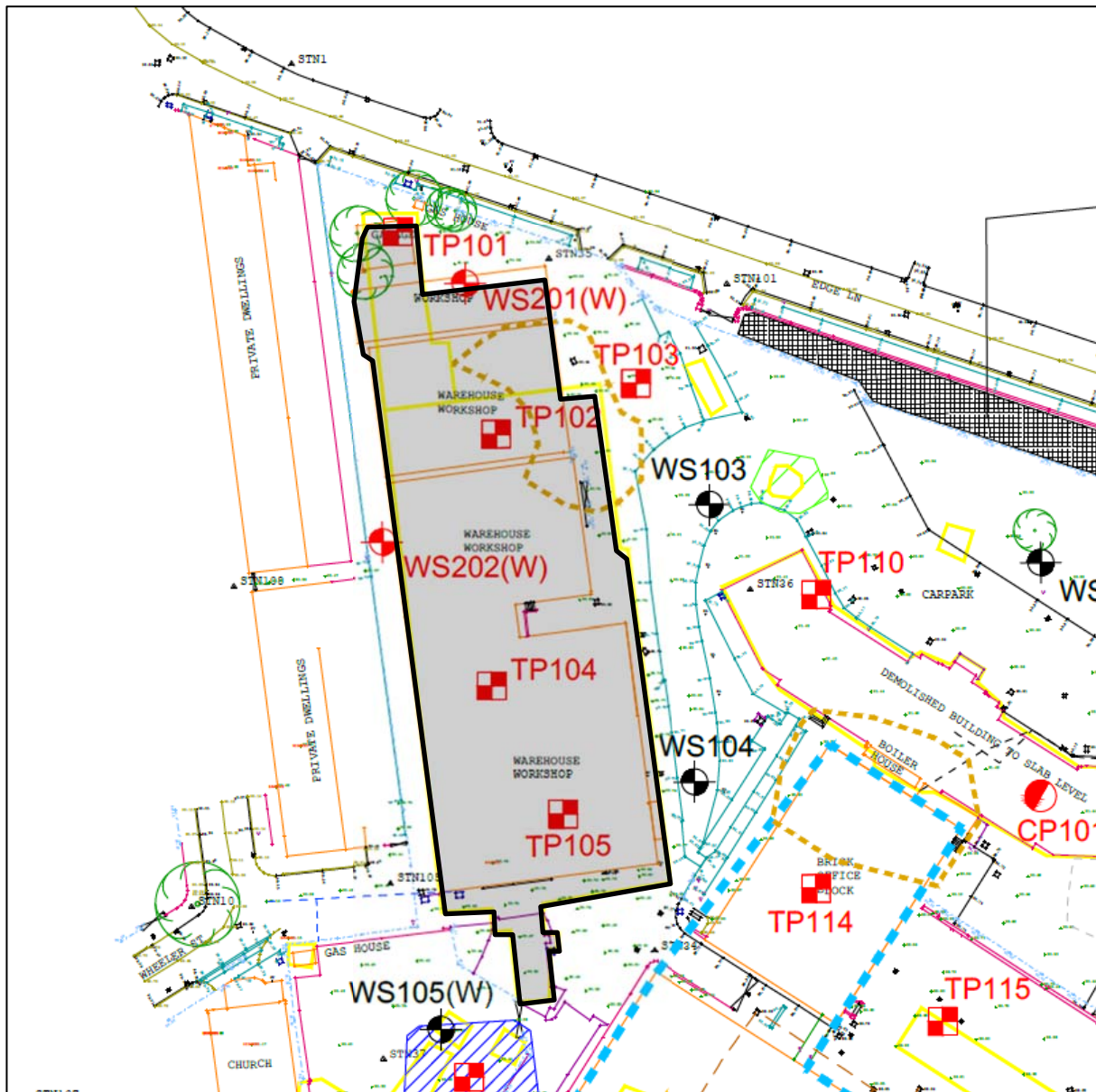
Additional trial pits were undertaken to visually assess the hotspot extent with validation samples collected to prove lateral and vertical extent impacted strata, and ensure it does not extend beyond the former building footprint.

The results of the testing for Area A are shown below;

Location	Depth (mbgl)	Determinant	Observed Concentration (mg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
A1	0.25	Lead	353	-	200
		Asbestos – Amosite Loose	0.001	<0.001	<0.001
		Benzo(a)pyrene	2.27	2.05	4.95
A3	0.60	Benzo(a)anthracene	13.3	8.54	-
		Benzo(a)pyrene	10.8	2.05	4.95

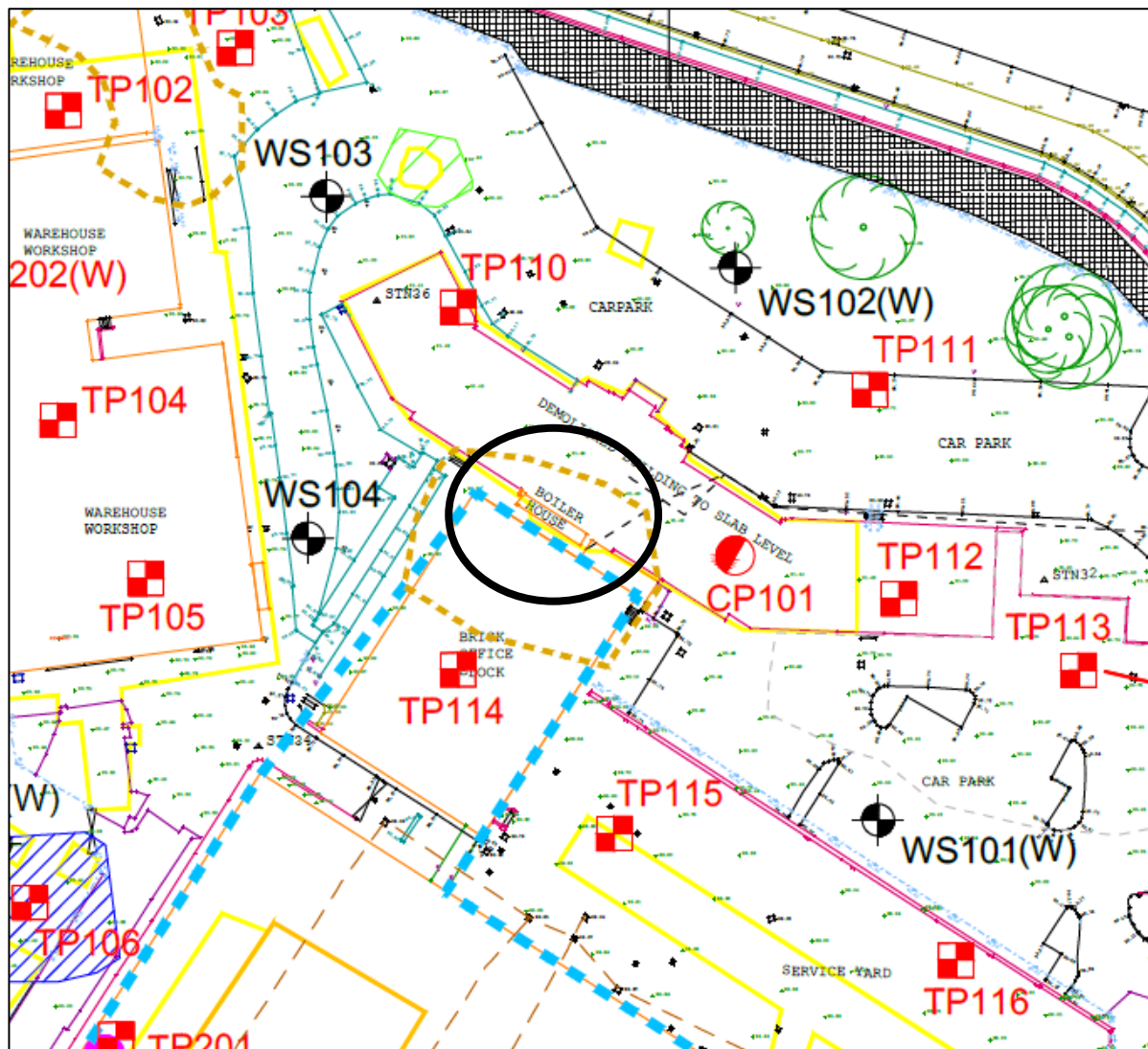
A4	1.00	Benzo(b)Fluoranthene	14.1	1.51	4.95
		Dibenzo(ah)anthracene	1.33	1	-
		Asbestos – Chrysotile Loose	0.059	<0.001	<0.001
A7	1.00	Benzo(a)pyrene	2.68	2.05	4.95
SVOCs					
Location	Depth (mbgl)	Determinant	Observed Concentration (µg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
A4	1.00	Dibenzofuran	1220	-	-
		Carbazole	906	-	-
		Bis(2-ethylhexyl)phthalate	872	-	-
		2-Methylnaphthalene	495	-	-
		n-Dibutylphthalate	6640	-	-
		Perylene	2470	-	-
		Chloroethane	56	-	-
		1,1-Dichloroethene	8	-	-
		1,1-Dichloroethane	250	-	-
		cis 1,2-Dichloroethene	3	-	-
		1,1,1-Trichloroethane	514	-	-
		Trichloroethene	3	-	-

A 600mm clean and inert capping system with geotextile at the base will be installed the areas identified on the drawing below which will provide sufficient protection to the end users. Due to the residual TCE



3.3 Further Investigation and Delineation of Basement Boiler House (Pre-Construction)

The boiler house located in the central northern area of the site required further investigation due to observed hydrocarbon odours during existing foundation exposure / removal work undertaken during the demolition phase of site works. The original location was covered by a large stockpile of 6F2 in the first phase of investigation and the known basement base in which the boiler house was situated was deemed too deep to be investigated during the initial investigations (>4.5m deep from existing levels). The approximate location of the boiler house is shown below;

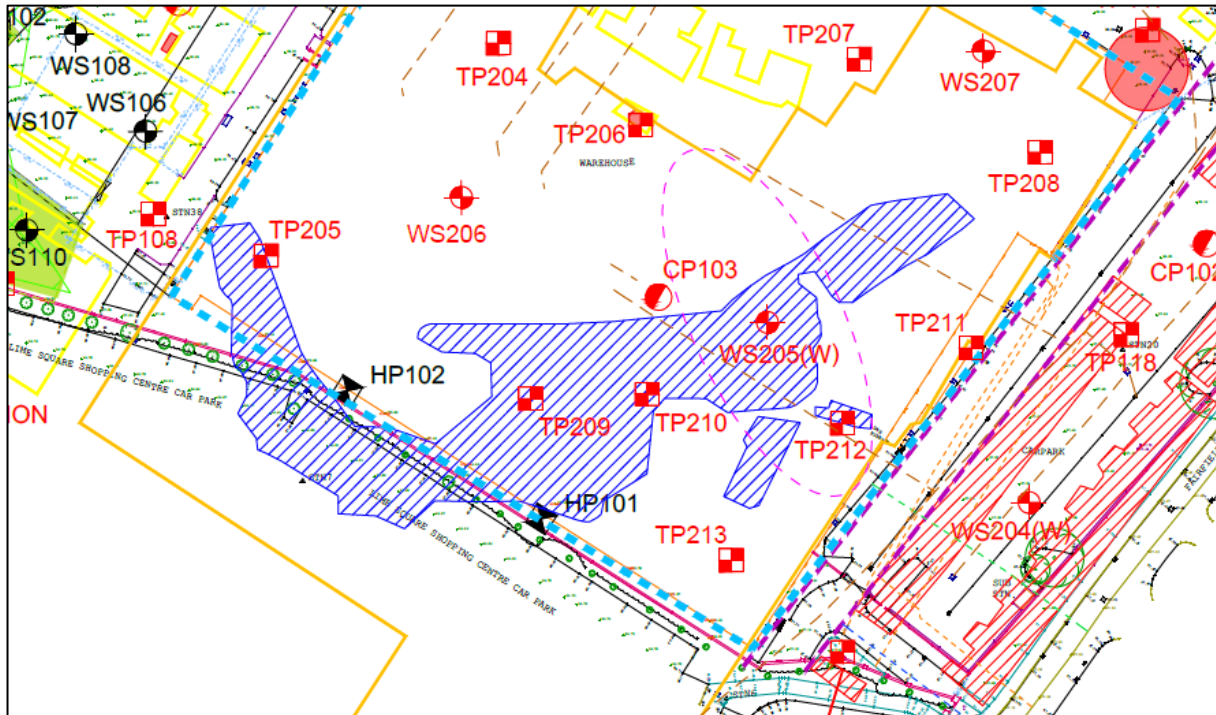


Samples collected from the base of the excavation showed no significantly elevated PAH, TPH or VOC/SVOC readings. The impacted materials are therefore considered to have been removed during the enabling works.

3.4 Investigation into Former Pond Area (Pre-Construction)

Additional delineation via trial pits or trenches for road and foundation design is required during the earthworks / cut and fill.

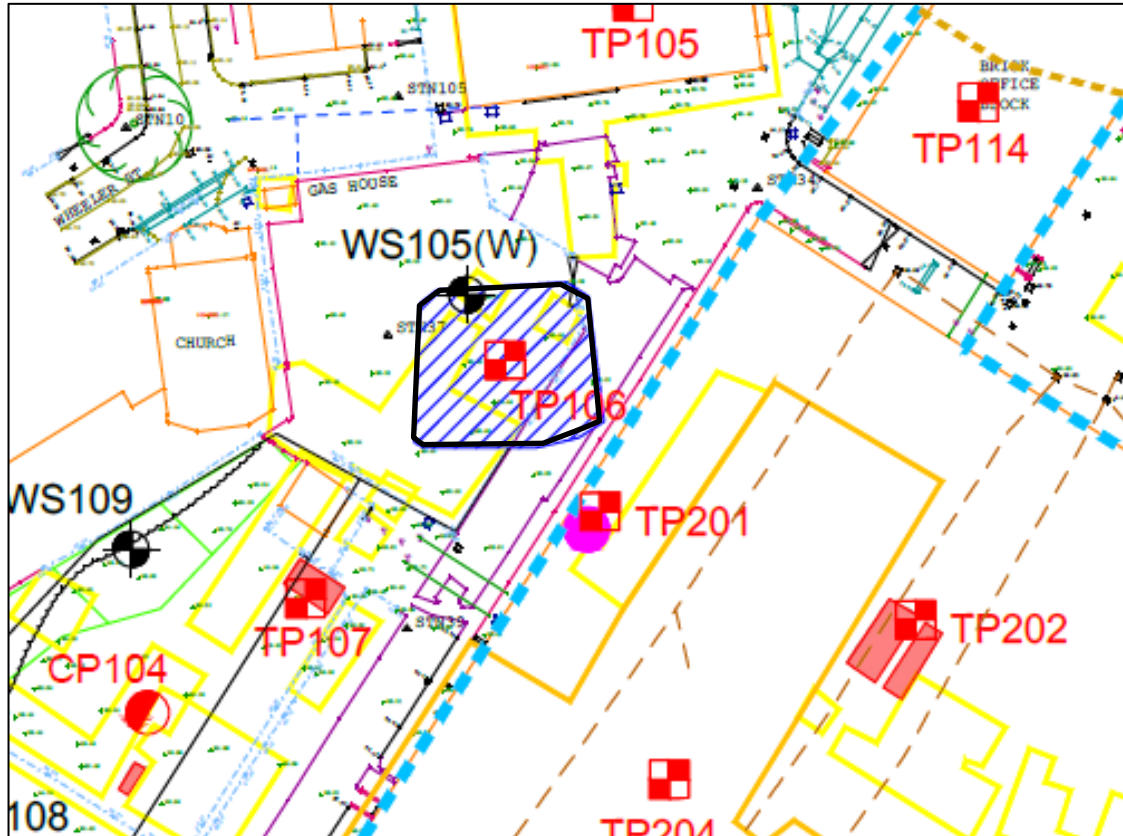
The anticipated location of the pond is shown below;



During the remediation work in this locality no significant evidence of a former pond was noted. It is suggested given the shallow impermeable clay that the ponding was shallow surface standing water at time of OS mapping.

3.5 Machine Pit Investigation (Pre-Construction)

During the demolition works (for which Betts Geo had a part time watching brief on) a machine pit was identified and excavated. The machine is pit located in the west of the site and is shown approximately on the plan below, this area is also shown as an historic pond. Historical maps also show the area to be identified as a possible boiler house.



The materials excavated from this area were shown to contain potential asbestos containing materials. Further investigation was required to show the extent of the machine pit / pond and determine the concentration of asbestos, as detailed in the section below.

3.6 Possible Asbestos Containing Material Stockpile (Pre-Construction)

A small stockpile onsite has been noted as being comprised, in part, of asbestos containing materials (ACM), this material has been surveyed and sampled. The approximate volume has been determined as 21m³, and 3no. samples were collected.

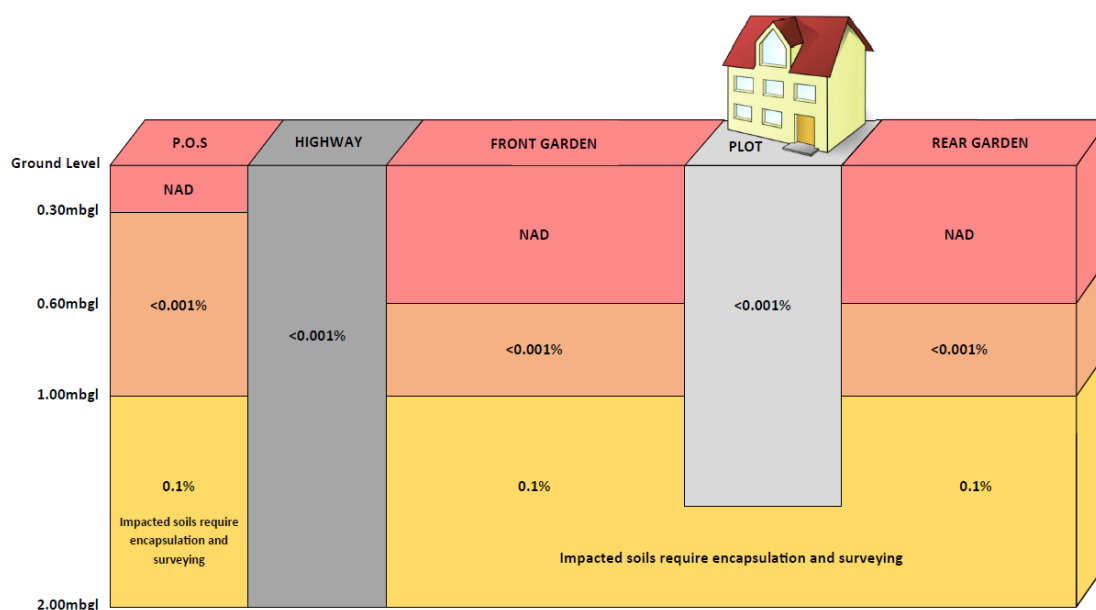
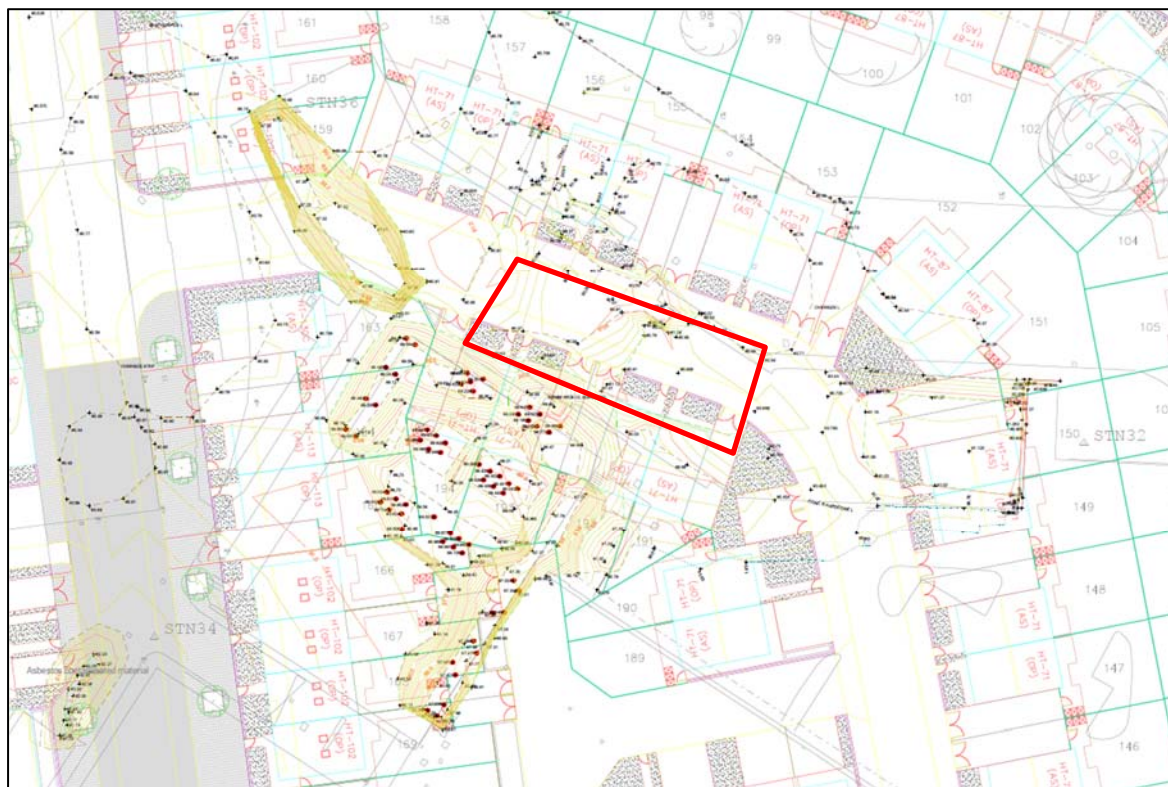
Testing of the materials determined the following concentrations;

Sample	Concentration (%)	Notes
ASP1	2.321	Amosite and Chrysotile
ASP2	0.766	
ASP3	4.346	

This stockpile will be buried at a depth >2.00m below proposed finished site levels as per the sketch below, within the former boiler house excavation, and will be encapsulated within natural clay at the base and sides, overlain by engineered fill and a membrane. Burial depth is to be determined by the proposed drainage depth and will be placed below any statutory buried service depth, surveyed, and recorded in a verification report. Consideration to a marker geotextile should be made if the depth is less than 1m below proposed drainage / services.

Part of the above, and any additional asbestos from the scrape, in remediation Area A and F, will also be deposited in the excavation discussed in section 3.6.

Regulatory approval agreed with Rebecca Twigg MCC (see appended emails) and agreed that the asbestos burial must not coincide with private driveways, gardens and or under plots. An accurate burial survey plan will be provided by the remedial contractor.



Notes:

P.O.S - Public Open Space

NAD - No Asbestos Detected

0.001% - Soils may contain $\leq 0.001\%$ using composite testing to ensure there is no potential risk to human health. Value is present where there may be short-term low level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (e.g. dust suppression).

0.1% - Soils at depth of $>1.00\text{mbgl}$ may contain $<0.1\%$ asbestos using composite testing where they will be not likely not be disturbed in the future and will therefore be in an area of Low Sensitivity. Risk assessment completed in accordance with the Asbestos JIWG Risk Assessment Tools.

Undefined - Dependant upon soils encountered during earthworks, which may be placed at depths to ensure no potential risk to human health.

Burial and encapsulation of asbestos should be agreed with regulators and consultant prior to the works being undertaken. Consideration should also be made to CAR-SOIL™.

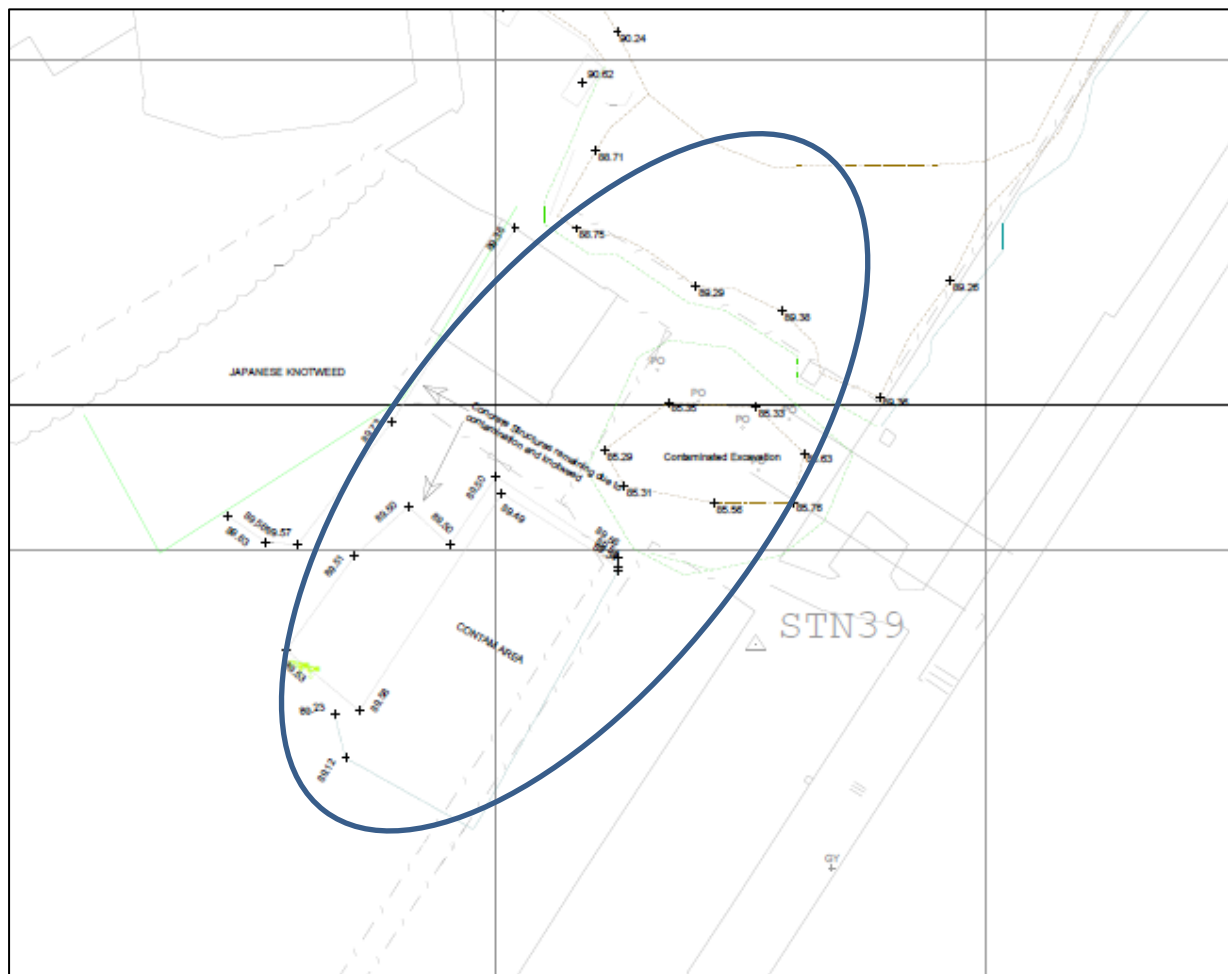
3.7 Hydraulic Test Bay / Boiler House (Area B) and Sump Soil Sampling (Area C)

Soil samples were collected from the sump in the central section of the site, and the Hydraulic Test bay and Boiler House area to the west of the site. The locations are shown on the drawings below;

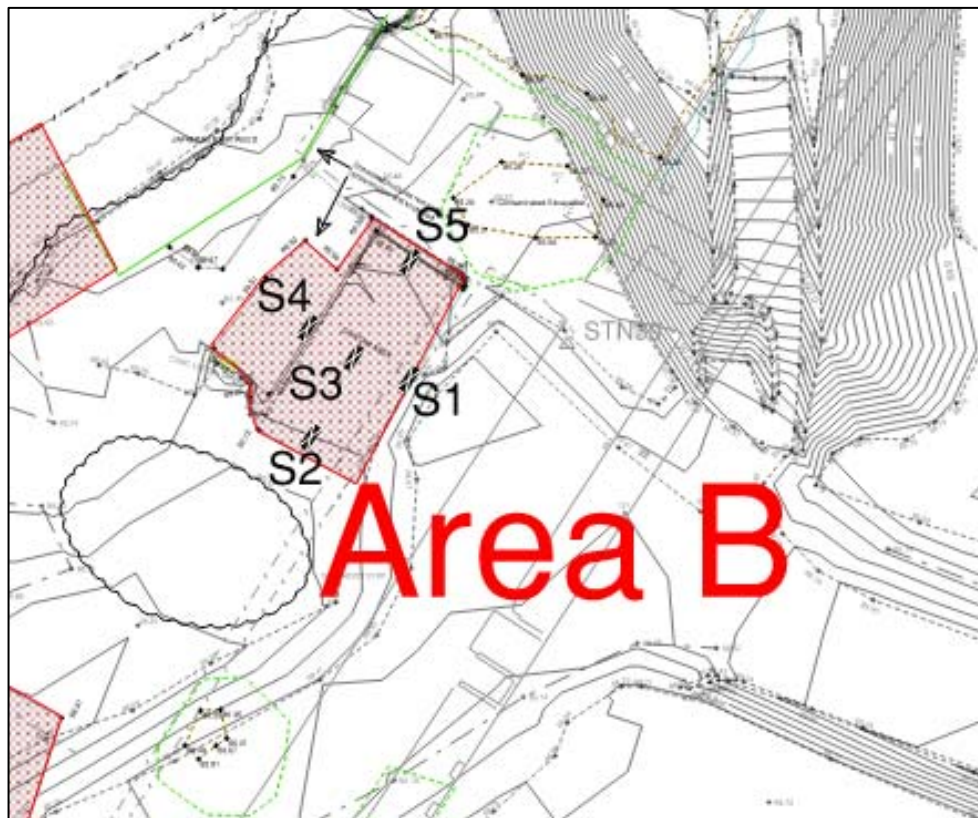
Hydraulic Test Bay (Accumulator) / Boiler House Location (Area B)

This area contained a deep concrete lined void that had been backfilled with demolition waste, this void has accumulated water overtime which requires pumping to a tanker and removed from site. The water was tested prior to offsite disposal and removed by CSG Ltd under supervision of Skillings.

The Hydraulic Test Bay / Boiler House Area was delineated via 4no. samples of the surrounding natural strata once the concrete had been broken out, the results are shown below;

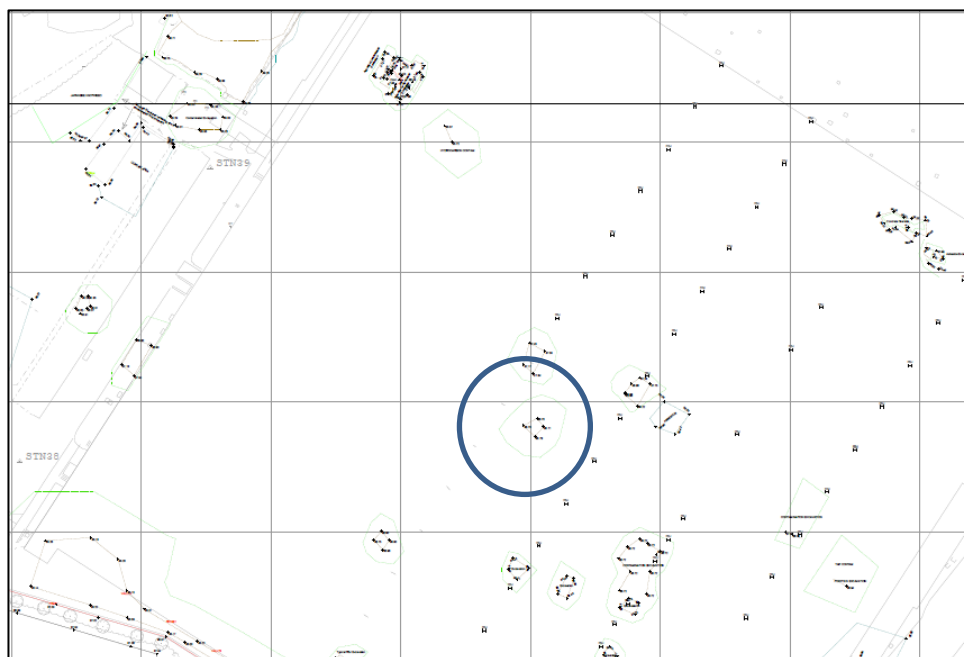


The locations of the sampling are shown below;



Testing of the surrounding natural strata has shown no elevated concentrations when compared against residential thresholds.

Sump Location (Area C)



The results are summarised below;

Location	Depth (mbgl)	Determinant	Observed Concentration (mg/kg)	SGV / GAC Used (mg/kg)	C4SL (mg/kg)
SUMP 1	-	Arsenic	35	32	37
		Lead	341	-	200
		Benzo(a)anthracene	7.9	8.54 (6% SOM)	-
		Benzo(a)pyrene	7.33	2.05 (6% SOM)	4.95
		Benzo(b)fluoranthene	7.74	9.86 (6% SOM)	-
		Dibenzo(ah)anthracene	1.14	1 (6% SOM)	-
SUMP 2	-	Arsenic	58	32	37
		Benzo(a)anthracene	13.2	8.54 (6% SOM)	-
		Benzo(a)pyrene	12.1	2.05 (6% SOM)	4.95
		Benzo(b)fluoranthene	13.7	9.86 (6% SOM)	-
		Dibenzo(ah)anthracene	1.71	1 (6% SOM)	-
		Indeno(123-cd)pyrene	8.21	9.75 (6% SOM)	-
SUMP 3	-	Arsenic	35	32	37
		Benzo(a)pyrene	2.67	2.05 (6% SOM)	4.95
SUMP 4	-	Arsenic	54	32	37
		Lead	1310	-	200
		Benzo(a)anthracene	6.72	8.54 (6% SOM)	-
		Benzo(a)pyrene	5.5	2.05 (6% SOM)	4.95

Elevated VOCs/VOCs and PCBs were also noted within the Sump and Boiler House samples as shown below;

VOCs/SVOCs

<u>Sump</u>	Depth (mbgl)	Determinant	Observed Concentration (µg/kg)
SUMP1	-	Dibenzofuran	693
		Carbazole	598
		2-Methylnaphthalene	341
		cis 1,2-Dichloroethene	17
		Trichloroethene	31
SUMP2		Dibenzofuran	5600
		Carbazole	2930
		3+4-Methylphenol	114
		2-Methylnaphthalene	4130
		trans 1,2-Dichloroethene	1
		cis 1,2-Dichloroethene	15
		Trichloroethene	35
SUMP3		Dibenzofuran	140
		Carbazole	109
		trans 1,2-Dichloroethene	15
		cis 1,2-Dichloroethene	135
		Benzene	1
		Trichloroethene	1180
SUMP4		Dibenzofuran	354
		Carbazole	300
		2-Methylnaphthalene	126
		trans 1,2-Dichloroethene	3
		cis 1,2-Dichloroethene	41
		Trichloroethene	24
<u>Boiler House</u>	Depth (mbgl)	Determinant	Observed Concentration (µg/kg)
BHO2		Bis(2-ethylhexyl)phthalate	719
		1,1-Dichloroethene	2
		trans 1,2-Dichloroethene	8
		1,1-Dichloroethane	2
		cis 1,2-Dichloroethene	661
		Trichloroethene	1090
		Tetrachloroethene	2
BHO4		2,4-Dinitrotoluene	1270
		1,1-Dichloroethene	35
		trans 1,2-Dichloroethene	56
		1,1-Dichloroethane	9
		cis 1,2-Dichloroethene	1290
		1,1,1-Trichloroethane	9
		Trichloroethene	2080
		Tetrachloroethene	4

PCBs

Location	Depth (mbgl)	Determinant	Observed Concentration (mg/kg)	SGV / GAC Used (mg/kg)
BHO2	-	PCB BZ 52	0.004	-
		PCB BZ 101	0.01	-
		PCB BZ 138	0.011	-
		PCB BZ 153	0.006	-
		Total Speciated PCB-EC7 & WHO12	0.031	0.01

These materials, and any other deemed to be similar, are to be delineated, excavated and stored over Visqueen, or in a skip prior to reassessment and the appropriate disposal method being decided.

Further samples were taken from around the sump (Area C) as part of the delineation works;

Location	Depth (mbgl)	Determinant	Observed Concentration (mg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
C - W	1.00	Lead	241	-	200
C - S	1.40	Arsenic	110	32	37
		Lead	2160	-	200
		Benzo(a)anthracene	19.4	8.54	-
		Benzo(a)pyrene	10.3	2.05	4.95
		Benzo(b)fluoranthene	12.7	9.86	-
		Dibenzo(ah)anthracene	1.19	1.00	-

Exceedances were only recorded in southern and western delineation holes are recorded against lead, arsenic and several PAHs.

None of the above exceedances are deemed to pose when a risk where overlain by a 600mm clean and inert cover system.

3.8 Area D Delineation

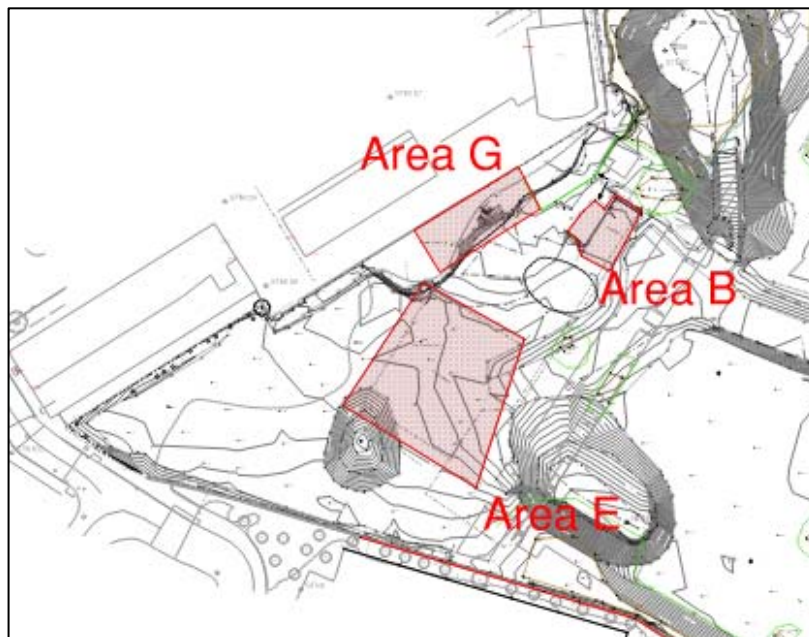
Area D, once cleared of water, was broken out and delineated via 4no. trial pits with samples of the surrounding strata collected. The materials were analysed for a broad range of determinants and no significantly elevated concentrations were observed. The area is deemed to be suitable delineated.

Area D is shown below;



3.9 Basements / Air Raid Shelters on Western Boundary (Area E)

During the Japanese knotweed scrape further basements / air raid shelters were noted on the western boundary. Their location is shown on the sketch below;

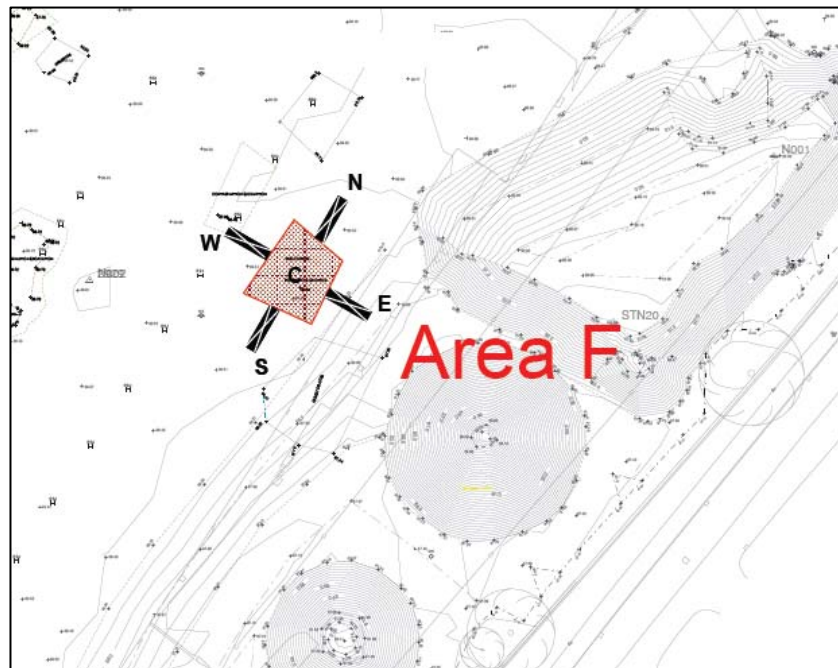


These locations are going to be treated in two phases. The top half, above the water line, is to be broken out and stockpiled separately over Visqueen, before being deposited in the Japanese knotweed cell.

The water contained within the void will then be pumped and the remaining structure will be pressure washed, broken down and removed from site to a suitably licensed facility, as will the water from the void and the water used to clean down the structure.

3.10 Area F Delineation

Area was delineated via five trial pits with samples collected from the approximate north, east south, west and central areas of hotspot.



Exceedances of lower magnitude were recorded in the southern and western pits of Area F and were noted against Arsenic and Lead. The table below summarises the exceedances.

None of the above exceedances are deemed to pose when a risk where overlain by a 600mm clean and inert cover system. No further work was considered necessary.

Location	Depth (mbgl)	Determinant	Observed Concentration (mg/kg)	SGV/GAC Used (mg/kg)	C4SL (mg/kg)
F - S	1.00	Arsenic	54	32	37
		Lead	865	-	200
F - W	1.40	Lead	257	-	200

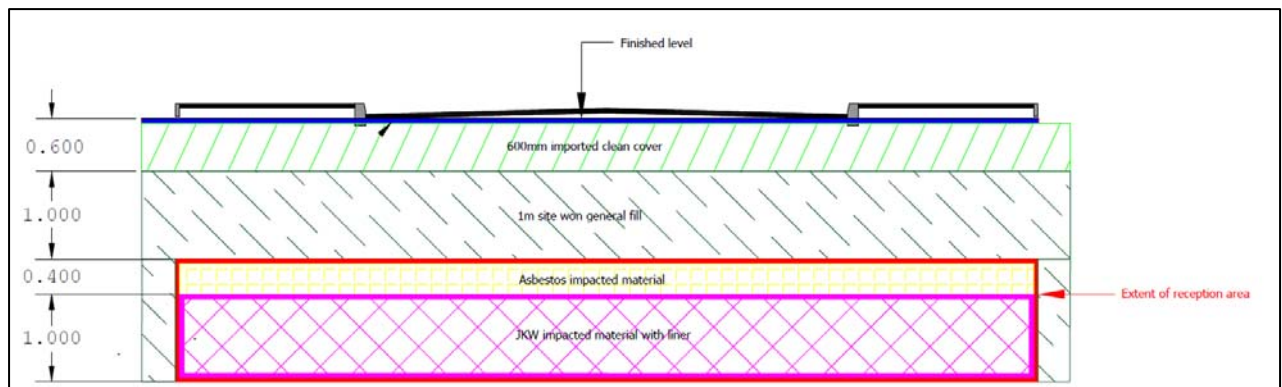
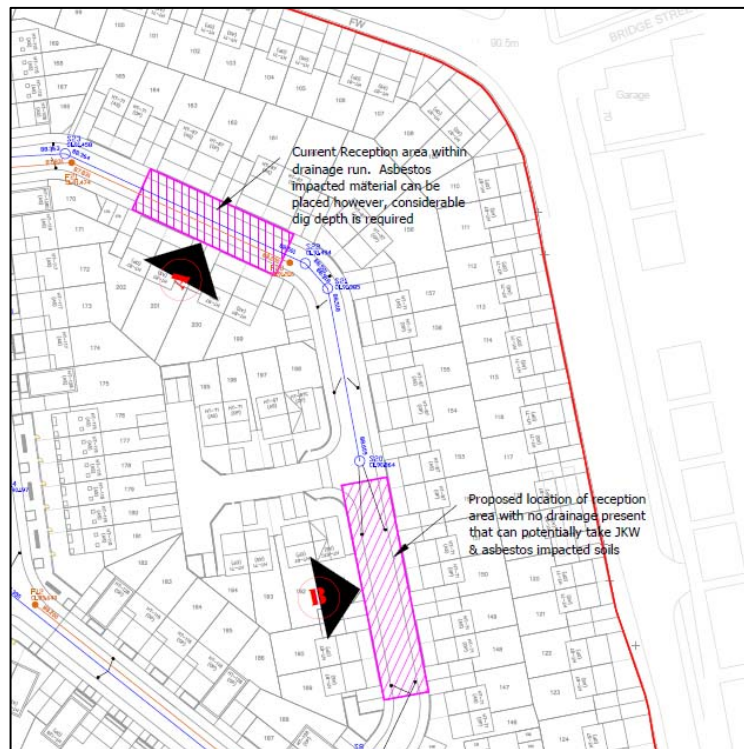
3.11 Japanese Knotweed (JKW) Excavation and Burial (Area G)

A Japanese knotweed stand has been observed in the southeast of the site, as shown approximately on the sketch below. These materials are to be excavated, encapsulated and buried at depth on site.



This area has been chosen based on its location away from proposed drainage runs, movement will be managed by a JKW Consultant and under a management plan.

The proposed cell location is given below; as is the proposed design;



The approval for this was sought from MCC CLO – Response received from Rebecca Twigg via email dated Mon 02/11/2020 stating that she had no objections to the proposal.

3.12 Perched Water Sampling

Perched water samples were collected from a tank area in the central section of the site, a sump area and what is believed to be an air raid shelter / basement in the southeast of the site.

The sample obtained from the air raid shelters showed no elevated concentrations when compared against the 2015 Water Framework Directive General Quality of Thresholds.

The water sampled from the tank showed exceedances of fluoranthene.

The results are summarised below;

Location	Sample Ref.	Determinant	Observed concentration (µg/l)	WFD 2015 Threshold used (µg/l)
Tank	Tank WS1	Fluoranthene	1.27	0.075
Sump	Sump WS1	Arsenic	21.4	7.5
		Nickel	20	15
		Selenium	16	7.5

Any perched waters found during enabling or remediation works are to be pumped to a tanker and removed from site to a suitably licenced facility and or disposed of to foul under UU discharge consent.

Note: these areas have been accurately surveyed in and backfilled with coarse oversize material and covered with Visqueen to stop migration / inundation of surface water until a time at which they can be dealt with.

Photographs of perched water areas are shown below;

Tank Water Sample Area



Area D



Basement / Air Raid Shelter Sample Area (Area E)



Upon removal, the hotspots and the sides and bases of these structures (with the exception of the air raid shelters) will require testing for verification purposes as per the testing frequency in section 4.3.3

The area of former air raid shelters will require re-engineering during the earthworks to provide a suitable foundation solution and mitigate potential differential settlement issues. – Survey drawing of extent currently being produced.

3.13 Deep Obstructions and Piles

All obstructions observed to a depth of 2.00mbegl or greater will be required to be accurately surveyed to feed into the development of a foundation zoning plan.

Piles from former structures where encountered have been surveyed during demolition.

3.14 Areas of Deep Fill Unsuitable for Vibro Ground Treatment

Areas deemed too deep and or unsuitable soils (e.g. clay content of made ground) for vibro ground treatment will be surveyed in and additional ground investigation undertaken using cable percussive holes to provide sufficient data for pile design.

3.15 Installation of Clean and Inert Capping (Construction Phase)

Due to the amount of chemical testing undertaken across site, the extent of the contaminated made ground can be estimated. As a result and depending on proposed ground works (due to the sites current stepped levels), it may be possible to remove the made ground material from site to allow a cover system of 300mm (150mm topsoil/150mm subsoil). If this approach is used, then the capping will be as follows;

Within Garden Areas (Made Ground removed)

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

If site levels allow, the contaminated materials could be retained on site, but below the clean and inert capping layer.

This will be reviewed once proposed site levels are known.

If the made ground is to remain on site, a 600mm cover system (150mm topsoil/450mm subsoil) with a geotextile no dig membrane at the bottom will be required to protect site end users, it will comprise the following;

Within Garden Areas (Made Ground left in-situ)

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

For landscaped areas, a 300mm cover system comprising 150mm topsoil and 150mm subsoil should be applied. This will be subject to Local Authority approval.

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 significant risk to construction workers is mitigated by the proper use of PPE and welfare facilities.

3.15.1 Unexploded Ordnance (UXO) Toolbox Talk

The regional UXO risk map described within the WA desk study report suggests the site is within a MODERATE risk area. Therefore, in the first instance, a desk based UXO report is recommended prior to significant construction takes place.

Due to the site seeing a number of phases of development after WWII, the risk is likely to be minimal, however, a toolbox talk should also be given prior to construction to address potential risk. The known bomb strike is shown to be west off site.

3.16 Site Won Soils

No topsoil of notable extent or quality is noted upon site and reuse is deemed unlikely. Should any be identified it will be stockpiled and tested to 1:50m³ basis due to the brownfield former use.

The use of Natural site won Clay may be possible, however, it is in general located at depth.

There is a significant visual difference between the Made Ground and natural clay material therefore, the two materials could be stockpiled separately following excavation. Any site won natural material will need to be chemically and visually assessed within the stockpile before re-use within garden areas.

The use of site won material will be subject to suitability testing as per the Local Authority's guidance. Confirmation of the testing will be required, as per the schedule below;

Intended End Use	Source / Origin of Material		
	Greenfield	Remediated	Brownfield / Unknown
Gardens	1:200m 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

Former structures encountered during the ground investigation could be used as part of the capping layer (once removed and crushed), if found geotechnically suitable.

Copies of all waste transfer documentation for material removed from site will need to be provided.

3.17 Imported Soils

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, as show below;

Intended End Use	Source / Origin of Material		
	Greenfield	Remediated	Brownfield / Unknown
Gardens	1:200m 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

Imported subsoil being brought to site should be tested for contamination to ensure that it is suitable for the proposed use, and it is generally advisable to test a minimum of three samples, or one sample per 200m³ so that a representative mean value can be calculated.

3.18 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 imported soils should be tested for contamination to ensure that they are suitable for the proposed end use as per Section 3.2 and 3.4.
- 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 therefore vigilance should be adhered, and any suspected asbestos should be notified and a suitably qualified.
- 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.

3.19 Drinking Water Supplies

Use of Protect-A-line is anticipated due to the presence of SVOCs / VOCs and TPHs. Upon completion of the earthworks and finished working platforms it may however be feasible to undertake additional testing along the proposed routes to try to mitigate the need for protect-a-line.

3.20 Review of Conceptual Site Model

Target (Receptor)	Potential Source-Pathway Linkage	Remedial Action Required (where appropriate)	Estimated Degree of Risk to Target Following Remedial Action Where Necessary
Site End Users	Inhalation of soil gases, odours or dust.	No gas protection is currently thought to be required; <u>this will be reviewed upon completion of gas monitoring – to be reported in verification report.</u>	Low
Site End Users	Ingestion of, and skin contact with, contaminated soil.	<u>Made Ground in place</u> - 600mm clean cover system (150mm debris free topsoil/450mm subsoil) with geotextile membrane at base. <u>Made Ground removed</u> – 300mm clean cover system (150mm debris free topsoil/150mm subsoil) with geotextile membrane at base.	Low
Site End Users	Ingestion of contaminants in vegetables etc. or in soils adhering to vegetables, etc	<u>Made Ground in place</u> - 600mm clean cover system (150mm debris free topsoil/450mm subsoil) with geotextile membrane at base. <u>Made Ground removed</u> – 300mm clean cover system (150mm debris free topsoil/150mm subsoil) with geotextile membrane at base.	Low
Construction / Maintenance Workers.	Inhalation of soil gases, odours or dust.	PPE	Low **
Construction/ Maintenance Workers.	Ingestion of, and skin contact with, contaminated soil	PPE	Low **
Plants	Adverse effects on growth caused by presence of contaminants in soil	<u>Made Ground in place</u> - 600mm clean cover system (150mm debris free topsoil/450mm subsoil) with geotextile membrane at base. <u>Made Ground removed</u> – 300mm clean cover system (150mm debris free topsoil/150mm subsoil) with geotextile membrane at base.	Low
Buildings and Structures	Flow of ground gas into buildings. Asphyxiation, toxicity, explosion and fire hazards	No gas protection is currently thought to be required – <u>to be reported in verification report.</u>	Low
Foundations	Sulphate attack of foundations	Foundations to be designed as per the ground investigation report.	Low
Water Supplies	Hydrocarbons penetrating plastic water supply pipes.	UU Risk Assessment Required. Protect-A-line anticipated.	Low

Target (Receptor)	Potential Source-Pathway Linkage	Remedial Action Required (where appropriate)	Estimated Degree of Risk to Target Following Remedial Action Where Necessary
Groundwater	Migration of soluble contaminants into groundwater on or off site	No remedial action required. Significant thickness of clay will limit vertical migration.	Low
Surface Water	Migration of soluble contaminants and/or direct run-off of contaminants	No remedial action required cohesive strata will limit horizontal migration.	Low

** assumes basic PPE is used

4 REMEDIATION STRATEGY

4.1 Aims

Remediation aims are:

- Remove / treat ground contamination issues in order to protect human health and potential environmental receptors, and render the site suitable for the proposed development
- Satisfy planning requirements of the Local Planning Authority.
- Satisfy Environmental Protection Act 1990 Part IIa requirements of the Environment Agency.

4.2 Remediation Scope

The following remedial works are required:

- UXO Toolbox talk.
- General site clearance of surface materials and vegetation.
- Breaking up and processing all suitable uncontaminated artificial hard material (i.e. concrete / brick etc) for re-use on site / disposal.
- Delineation and validation of TP104 hotspot.
- Further Investigation into boiler house post basement excavation (was historically demolished and levelled into the basement void)
- Investigation into former pond area as and when asbestos strip and demolition of the super structure allows safe access. Additional gas monitoring is outstanding (2 visits additional required)
- Investigation into machine pit near to the boundary with the Church.
- Investigation into the area of the former transformer and pitch lined walls.
- Sampling of possible asbestos containing materials within a stockpile.
- Management of soils to ensure all materials impacted by asbestos fibres are placed in areas of low sensitivity during the site enabling works.
- Excavation of soil / brick rubble and removal of below ground obstructions.
- Surveying all piles exposed during the demolition works to allow detailed foundation appraisal.
- Backfill of all resultant excavations (and re-excavation where backfill has been undertaken as part of the demolition but no re-engineering undertaken), with demonstrably clean materials to engineered specification in general accordance with series 600 and compliance with expected standards by the NHBC for acceptable settlement for both the plot and surrounding driveways / hardstanding, gardens and roadways.
- Ensure post remediation phase (pre construction) that the site is adequately drained and ponding of water is mitigated by the remediation contractor and maintained until a principal contractor purchaser is appointed.
- Construction of roadways to the acceptance of the local authority highway inspectors specification.
- Re-grade of site to specified levels.

- Provision of a clean and inert capping layers as described in section 3.2. Cover layer should be debris free as per NHBC guidance.

4.3 Remediation Methodology

4.3.1 Site Set-up, Organisation and Safety

Site works will be supervised throughout by a suitably qualified Engineer, who will report to the Project Manager. Consultancy supervision may be part-time for certain activities but must be full-time during the removal of any grossly contaminated soil \ fill and any placement of fill to an engineering specification.

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.

Note: Specialist PPE and decontamination units will be required for asbestos removal by a specialist. Detailed methodology of asbestos removal to be covered by third party method statements.

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.

4.3.2 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.

4.3.3 Engineering Supervision and Validation

Betts understand that the Engineer will ensure that the requirements of this RS are complied with in a safe and orderly manner.

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.
- Where material is found to contain concentrations of potential contaminants at levels in excess of the site specific screening criteria the engineer will undertake further assessment and recommendations on the appropriate use for the material in question, which may involve the disposal of such materials off-site to a suitable waste management facility.

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 remedial and ground preparatory works have been carried out in accordance with this RS.

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.
- Chemical testing for suitability for reuse and compliance with the MMP (undertaken by others)
- 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.

The sampling frequency for materials to be managed under the Remediation Strategy is presented within the table below:

Specification of Chemical Validation Laboratory Analysis

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Site Generated		
Site Generated 6F2	1 Sample Per 1000m ³	A / B / C / D
Site Won Made Ground General Backfill	1 Sample Per 1000m ³	A / B / C / D
Site Won Made Ground General Backfill	1 Sample Per 2000m ³	I
Site generated Sub-Soil (450mm garden cover)	1 Sample Per 200m ³	A / B / C / D
Hotspot Validation Samples Hydrocarbons	1 Sample per 10m of linear excavation to base and sidewall.	E / G
Imported		
6F2	1 Sample Per 1000m ³	A / B / C / D
Subsoil Greenfield Source (150mm garden cover)	1 Sample per 200m ³	A / B / C / D
Subsoil Brownfield Source (150mm garden cover)	1 Sample per 50m ³	A / B / C / D
Topsoil Greenfield Source (150mm garden cover)	1 Sample per 150m ³	A / B / C / D
Topsoil Brownfield Source (150mm garden cover)	1 Sample per 50m ³	A / B / C / D
General Engineering Fill (Class 1 & 2 Soil)	1 Sample Per 1000m ³	A / B / C / D

- A) Speciated PAH
- B) Speciated TPH
- C) Asbestos (ID and quantification if positive)
- D) CLEA Inorganic Heavy Metals
- E) Speciated PAH, Banded TPH and VOCs
- F) SVOC / Speciated TPH
- G) On-site screening for VOC using calibrated PID
- H) Leachate 2:1 Speciated PAH and Banded TPH
- I) Leachate analysis of Inorganic heavy metals, TPH, sulphate and PAH.

Current cut and fill models suggest that there will be circa 50,000m³ of reuse of site materials, comprising 50% recycled concrete products (i.e. 6F2 or Type 1) and 50% general fill – subject to review. Approximately 50no. samples required to assess suitability for reuse.

5 REMEDIAL WORKS (CONSTRUCTION OBJECTIVES)

5.1 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.

5.2 Reuse of Site Materials

All relevant Standard Rules Permits should be registered with the EA and the LAPC Part B Notification for deployment of mobile crushing plant should be implemented prior to the establishment of equipment on-site.

If the proposed volume of soils to be re-used (excluding site won crushed materials from hardstanding / foundations) exceeds the volumes and soil types benefited by the Standard Rules Permit / Exemptions, a CL:AIRE MMP Qualified Declaration should be made by the contractor having obtained full written approval for the Remediation Strategy from the LPA and Environment Agency.

It is not anticipated that there will be any requirement to treat any materials on-site such as hydrocarbon impact soil or groundwater), however should any previously unidentified contractor must either notify the EA of their intention to complete a minor works operation or arrange for the deployment of the appropriate Environmental Permit for the specified operation.

Sampling for the reuse of materials within the cut fill process will require the collection, testing and analysis of approximately 130no. samples.

5.3 Excavation of Hardstanding and Foundations

Given that the underlying natural clays 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.

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.

5.4 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.

5.5 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.

5.6 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.

5.7 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.

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.

5.8 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.

5.9 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.

5.10 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 with pre agreed testing frequency for validation purposes.

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.

5.11 Boundary Issues

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

5.12 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.

6 METHODOLOGY / PROGRAMME

6.1 Imported Soil

- 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.

Any soils intended for use as part of the clean cover (including site won material) will be tested at source or stockpiled on site until approved for use by the Supervising Engineer. Topsoil testing will be carried out at the frequencies below;

Intended End Use	Source / Origin of Material		
	Greenfield	Remediated	Brownfield / Unknown
Gardens	1:200m 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.

6.2 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.

Should any further water abstraction boreholes be located, they must be quarantined until they can be recorded, sampled and decommissioned. Site arisings must be kept away, ensuring none enter the well.

6.3 Construction Workers

Due to the presence of contaminated Made Ground soils, a risk exists (in the short term) to any ground/construction workers involved in the redevelopment of the site.

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.

6.4 Site Certification

Once the remediation works have been undertaken, a 'completion' report (as described in Section 4.3.3 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.

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 Your Housing Group. 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.