



e3p

Remediation and Enabling Works Strategy
Former Boddingtons Site, Cheetham Hill

Reference:15-175-R3-4
Date: March 2022



REMEDIATION AND ENABLING WORKS STRATEGY

Former Boddingtons Site
Great Ducie Street
Cheetham Hill
Manchester
M3 1PT

Prepared for:
Latimer Developments Ltd

Report Ref: 15-175-R3-4
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EXECUTIVE SUMMARY

Site Address	Former Boddingtons Site, Cheetham Hill, Manchester, M3 1PT
Grid Reference	E383786, N399268
Site Area	0.49 Ha.
Background	E3P has been instructed by Latimer Developments Ltd to develop a remediation and enabling works strategy for the proposed mixed-use development comprising 461 residential units, and commercial spaces at the site known as the Former Boddingtons Site, Cheetham Hill, Manchester. The development will comprise two main blocks with differing numbers of stories, between 1 story and 26 stories. This Remediation and Enabling Earthworks Strategy report has been produced in due consideration of the geoenvironmental site investigation and contaminated land assessments undertaken by E3P.

CONTAMINATED LAND RISK ASSESSMENT

Human Health Risk Assessment	The Tier I Human Health Risk Assessment has identified the presence of elevated concentrations of inorganic heavy metals, PAH compounds and naphthalene within Made Ground deposits. The Made Ground is not suitable for use within proposed “soft” areas, where a direct exposure pathway exists. Elevated TPH has been identified within underlying natural strata at a depth of 5.60 m bgl in one location (WS108). All landscaped areas will require the placement of a 450 mm chemically suitable cover system (comprising a capillary break layer, 300 mm subsoil and 150 mm topsoil) to remove the exposure pathway and ensure no unacceptable risk to human health receptors in line with the Manchester City Council guidance document. Localised naphthalene impacted materials within WS109 at 0.80 m bgl will require delineation and removal of impacted soils as it presents a risk of vapour inhalation to the proposed end-user. The delineation, excavation, and removal of all impacted soils with subsequent validation testing of the resulting excavation will demonstrate the removal of the contaminant source. The excavated impacted material can be subject to on-site ex-situ treatment with validation testing utilised to demonstrate options for future re-use. In terms of the localised TPH C16-C21 and TPH C21-C35 identified in one location on site within the underlying natural SAND (WS108 at 6.60 m bgl), the pathway for these compounds is dermal contact and ingestion and given the depth of the identified impact (>5.00 m bgl), it is unlikely that this will pose a future risk to the proposed development in terms of human health. Localised, as yet unidentified, contaminant impact cannot be discounted; therefore, the site remediation and enabling works will be completed under the supervision of an independent geoenvironmental engineer. In the event of any as yet unidentified/unexpected source impact being observed, samples will be subject to laboratory testing to inform robust risk assessment and, where necessary, remedial action.
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Controlled Waters Risk Assessment	The direct comparison of groundwater samples recovered from dedicated monitoring wells has identified elevated concentrations of selenium and TPH Aliphatic C21-C35 within one location (WS108) which exceed the screening criteria for the Drinking Water Standards (DWS). Elevated TPH Aliphatic C21-C35 within WS108 are considered to be associated with the hydrocarbon impacted SAND deposits. The CL:AIRE Petroleum Hydrocarbons in Groundwater guidance document shows the mobility ranking of TPH carbon bandings; TPH Aliphatic C21-C35 are not included however TPH Aliphatic C16-C21 are considered to have a very low sorption ranking and potential mobility ranking, and overall relative mobility in groundwater assessed as being very low. Given the elevated TPH bandings identified in the groundwater analysis it is considered they will have low mobility so are unlikely to migrate. The groundwater samples were obtained using a low flow technique, and it is recommended further monitoring be completed across the site to understand if there is site-wide impact. It should be noted that the elevated concentrations of selenium and TPH Aliphatic C21-C35 are typically considered to be of low mobility. Given the absence of any notable receptors within proximity to the site, the low mobility of the identified contaminants which exceed DWS screening criteria, there is considered to be a low risk to controlled waters. Further groundwater monitoring should be completed comprising at least two additional visits using a low flow sampling technique to confirm these findings.
Ground Gas	Based on the ground gas monitoring completed the subject site would be classified as CS1 for the proposed development area, and therefore ground gas protection measures are not required within the construction of the proposed development.
Coal Mining and Historical Workings	The site is not considered to be at risk from mining or quarrying-related issues.
Potable Water Supply	The site investigation and contaminant risk assessment identified elevated concentrations of potentially volatile hydrocarbon compounds, which could permeate into the potable supply infrastructure. It will therefore be necessary to undertake appropriate remediation works with robust validation tests including a post-remediation UKWIR assessment to confirm the proposed pipeline requirements.

GEOTECHNICAL ASSESSMENT

Relict Sub-Structures	All relict substructures, infrastructure and materials deemed geotechnically deleterious will require removal from beneath proposed structures and infrastructure to the depths and extents as defined within this specification.
Adverse Ground Conditions	All infilled and historical features where deleterious/putrescible material are encountered, should be subject to the necessary remediation works in order to render the site suitable for the proposed development.
Proposed Foundations	The overarching aims of the remediation and enabling earthworks will be: ☛ Preparation of plot footprint (+ 2 m on all elevations) to be suitable for a piled foundation solution.



Proposed Foundations	✦ Preparation of a temporary cover layer using locally-won recycled concrete aggregate to the structural engineers specification. Where structures are to be supported by the use of a pile foundation, all newly placed material will be engineered to ensure no unacceptable long-term consolidation/settlement that would induce negative skin friction and subsidence to external hardstand/landscaping.
Highways and Infrastructure	All proposed adopted roads will be constructed in accordance with the geotechnical engineering requirements as defined within the MCHW Series 600. Specific engineering and compaction of materials will be completed in strict accordance with the geotechnical specification contained within this report. All materials outside of structural/infrastructure development will be engineered and compacted to ensure consolidation associated with self-weight settlement is limited to < 50 mm in accordance with the E3P specification.

REMEDIATION AND ENABLING WORKS

Objectives	The remediation and enabling works will be delivered in a manner that will seek to ensure that the site is prepared to deliver the optimum foundation solution for the proposed structures, infrastructure and highways. The structural engineer's drawings should be referenced in addition to this report.
Remediation and Enabling Works	The site remediation and enabling works strategy provide a comprehensive specification for the regeneration of the land to negate identified pollutant linkages and construct a development platform that will be geotechnically suitable for the proposed end-use. The salient features of the remediation and enabling works strategy are summarised as follows: ✦ Implementing all works in strict accordance with UK Environmental Permitting and local planning authority requirements. ✦ Pre-commencement supplementary site investigation within areas of limited access during the previous E3P site investigation in the south and west of the site. ✦ Removal of all hardstanding, structures, relict foundations and buried features in their entirety (with the exception of live services until re-located if required). ✦ Crushing of hardstanding for re-use on site in the temporary cover layer and stockpiling of surplus for possible future use. ✦ (Only if encountered) The identification, delineation and excavation of potential asbestos impacted materials and validation testing of material that remains and removal of all unsuitable soils in a controlled and legislatively compliant manner. ✦ Delineation and excavation of naphthalene impacted materials and validation testing of material that remains and removal of all unsuitable soils. ✦ Groundwater sampling to confirm there is no unacceptable degree of risk to controlled waters. ✦ Removal of all materials considered geotechnically unsuitable. ✦ Excavation and processing of Made Ground in a controlled manner with the sorting, processing and segregation of identified deleterious materials to comply with the geotechnical specification.



	- Validation sampling and leachate testing to confirm material retained on-site poses no unacceptable risk to the residential end-users, controlled waters or wider environ. - Removal of surplus materials from site to achieve the reduced levels as per the engineers specification. - Replacement of material in accordance with the E3P enabling specification and engineering requirements. - Development of a suitably engineered temporary cover layer of locally-won recycled concrete aggregate.
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BUILD PHASE REQUIREMENTS

Summary of Build-Phase Mitigation Requirements	The developer's works will also include the completion of the following additional elements: - Provision of a 450 mm cover system with capillary break layer, using certified material with appropriate validation within proposed areas of public open space and soft landscaping. - Construction of appropriate potable water supply infrastructure.
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15-175-016 – Remediation Issues Plan



1. INTRODUCTION

1.1. BACKGROUND

E3P has been instructed by Latimer Developments Ltd to develop a remediation and enabling works strategy for the proposed mixed-use development comprising 461 residential units and commercial spaces at the site known as the Former Boddingtons Site, Cheetham Hill, Manchester. The development will comprise two main blocks with differing numbers of stories, between 1 story and 26 stories.

1.2. REPORT OBJECTIVES

The objectives of this report are to:

- ✿ Prepare an overview of contaminated land remediation requirements;
- ✿ Evaluate feasible remedial technologies;
- ✿ Assess the most-appropriate earthworks solution to ensure the delivery of the optimum development platform;
- ✿ Define validation criteria to demonstrate the successful implementation of the site remediation and enabling works plan;
- ✿ Specify geotechnical engineering performance requirements; and
- ✿ Ensure the safe, cost-effective and regulatory compliant redevelopment of the site.

1.3. SCOPE OF WORKS

The development of the risk management strategy for the subject site includes the following tasks:

- ✿ Identification of the relevant pollutant linkages;
- ✿ Review of site characteristics;
- ✿ Identification of geotechnical constraints;
- ✿ Development of remedial objectives;
- ✿ Selection of appropriate remedial technology; and
- ✿ Development of remedial strategy.

1.4. PREVIOUS WORKS

The following phases of geoenvironmental investigations have previously been carried out at the site:

- ✿ **E3P** – *Phase I Geoenvironmental Site Assessment*. Report Ref: 15-175-R1-2, dated December 2021, Prepared for Latimer Developments Ltd.
- ✿ **E3P** – *Phase II Geoenvironmental Site Assessment*. Report Ref: 15-175-R2, dated December 2021, Prepared for Latimer Developments Ltd.



To inform the assessment of the potential risk to contaminated land within the context of the proposed residential development and to inform the preparation of the remediation strategy, the pertinent points from the above report are summarised within Section 2.

For the avoidance of any doubt, the following reports should be read both as a precursor to and in conjunction with this document:

- ✿ **E3P** – *Phase I Geoenvironmental Site Assessment*. Report Ref: 15-175-R1-2, dated December 2021, Prepared for Latimer Developments Ltd.
- ✿ **E3P** – *Phase II Geoenvironmental Site Assessment*. Report Ref: 15-175-R2, dated December 2021, Prepared for Latimer Developments Ltd.

1.5. REDEVELOPMENT PLAN

E3P understands that Latimer Developments Ltd is involved with a proposed scheme to redevelop the site for residential use. Assael Architects has completed a feasibility study for a car-free development comprising 442 homes and commercial spaces. The development will comprise two main blocks with differing numbers of stories, between 1 story and 27 stories.

The site forms part of the adopted Great Ducie Street Strategic Regeneration Framework Masterplan, bringing forward the redevelopment of the former Boddingtons Brewery demolished circa 10 years ago. The site has been purchased from LTE Group (trading as Manchester College) who are delivering a new college facility on the southern part of the site, this is due for completion by summer 2022.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.6. SUMMARY OF PARTIES INVOLVED

FUNCTION/INTEREST	NAME OF PARTY
Local Planning Authority	Manchester City Council
Developer	Latimer Developments Ltd
Geoenvironmental Consultant	E3P
Main Contractor	TBC
Remediation/Enabling Works Contractor	TBC
Human Health Regulator	Manchester City Council
Controlled Waters and Waste Regulator	Environment Agency
Highways Adoption Authority	Manchester City Council

1.7. REGULATORY CORRESPONDENCE

Latimer Developments Ltd is in the process of submitting a detailed planning application to the local planning authority for the proposed redevelopment of the site for a combined commercial and high-rise residential housing as part of a car-free development.

It is presumed that as part of the planning approval process, the planning authority will undertake consultation with the pertinent statutory consultees, which will include:

- ✳ Environmental health/contaminated land officer at the local authority (or external adviser);
- ✳ Environment Agency planning liaison; and
- ✳ The Coal Authority.

1.8. SITE DETAILS

Site Address	Former Boddingtons Site, Cheetham Hill, Manchester, M3 1PT
National Grid Reference	E383786, N399268
Site Area	0.49 Ha.

All acronyms used within this report are defined in the glossary presented in Appendix II.

A site location plan is presented in Appendix III as Drawing 15-175-001.



1.9. SITE SUMMARY

TABLE 1.1 SITE DESCRIPTION AND SETTING

Occupancy/Use	The site currently comprises land bound by the Travelodge and surface level car parking to the north, the remainder of the surface level car parking and beyond this Dutton Street to the east, the under-construction Manchester College to the south, and Bury New Road to the west in Manchester.	
	The site is itself forms part of a surface level car parking with access gained via Francis Street to the northwest of the site.	
	The site is covered in hardstand with street lighting present along the boundaries of the site (except for the northern boundary which forms part of the wider car park). No structures are present within the site boundary.	
Environmental Setting	Drift Geology	Till – Diamicton (east of site) No superficial drift deposits recorded by the BGS in the west of the site.
	Bedrock Geology	Chester Formation - SANDSTONE
	Hydrogeology	Secondary undifferentiated superficial aquifer in the east overlying a principal bedrock aquifer. The west of the site has been noted as a secondary A aquifer, however, drift deposits have not been recorded.
	Faults	The Ardwick Fault is present across the site trending approximately north-west to south-east with the downthrow side present on the north-east of the fault.
	Hydrology	No surface water features are present on site. The nearest surface water feature is the River Irwell located 156 m south-west. Based on the local topography and location of nearby surface water features, it is likely that any shallow groundwater if present will flow in a westerly direction towards the River Irwell.
	Flood Risk	The site is located in a Flood Zone 2.
Site History	The subject site comprised buildings associated with print works along with Briddon Street and Nightingale Street in earliest mapping from 1848. By 1850 the site was named Strangeways Calico Print Works with several buildings, boilers and tanks on-site; terraced housing was present in the west of the site. In 1892 the site was named Strangeways Finishing Works with Albion Works present on the north-eastern boundary. Mapping from 1933 identified several industries on the site including boot repairs, rag and cotton warehouse, plumber, dentist, hotel, waterproof clothing factory, cotton goods warehouse, mortar mill, garage, quilt and clothing factory and an oil store. Terrace housing in the west of the site was demolished and replaced with a warehouse circa 1949-1951; by this time the site was part of Strangeways Brewery. Mapping dated 1978-1989 notes that Briddon Street and Nightingale Street were no longer present with large areas of the site cleared or demolished. The site then comprised the brewery and areas of hardstanding up until some point between 2006 and 2009 where the site was demolished and was subsequently utilised as a car park, which is still its current use.	



Landfill Sites and Ground Gases	No landfill sites (current or historic) are located within 250 m of the site. The site has undergone numerous phases of historic development which is likely to have resulted in the deposition of deep and variable Made Ground across the site, which may be a potential source of hazardous ground gases such as methane and carbon dioxide. Potentially infilled land (water and non-water) associated with unknown filled ground has been identified between 23 m and 248 m from the site.
Radon	Less than 1% of houses above the 'Action Level' – no special precautions required.



1.10. SUMMARY OF REPORTED GROUND CONDITIONS

E3P has prepared a detailed Phase II Geoenvironmental Site Assessment Report (Ref: 15-175-R2, dated December 2021). The summary of reported ground conditions is given in Table 1.2.

TABLE 1.2 SUMMARY OF GROUND CONDITIONS

MADE GROUND	MADE GROUND – 0.00 m bgl – 5.10 m bgl MADE GROUND was encountered within all exploratory hole locations to a maximum proven depth of 5.10 m bgl (WS108), however, typically made ground deposits were encountered at depths less than 3.00 m bgl. The majority of locations comprised concrete or asphalt in the upper 0.3 m with the exception of W101, WS102, WS104 and WS108 which comprised brown sandy gravel or gravelly sandy clay with gravel of brick, mudstone, concrete and sandstone. The underlying made ground deposits generally comprised sandy gravel with brick, coal, sandstone, concrete and occasional clinker (TP102 and WS110) and metal (ws110). Reworked silty clay deposits were identified within TP102 (1.40-2.20 m bgl), WS105 (2.00-3.10 m bgl), WS108 (1.00-2.60 m bgl). An organic odour was identified within made ground clay deposits in WS106 at 1.60-1.80 m bgl.
Drift	DRIFT – 0.40 m bgl – 6.70 m bgl Drift deposits were encountered within the majority of exploratory locations with the exception of those where the full depth of Made Ground could not be proven. Drift deposits were not encountered within TP102, TP103, WS101, WS102, WS109 and WS110. Brown silty CLAY was encountered within ten exploratory hole locations between the depths of 0.40 m bgl to a maximum encountered depth of 6.00 m bgl. CLAY deposits were generally firm to stiff, however soft very low strength CLAY was identified within WS105 at circa 5.00 m bgl. The CLAY deposits were typically identified to be underlain by a silty fine to medium SAND within four exploratory locations between depths of 1.80 m bgl to a maximum confirmed depth of 6.70 m bgl. SAND deposits were noted to be loose to medium dense. Loose SAND deposits were noted in BH102 at 2.00 m bgl. and BH104 at 4.00 m bgl. A SAND and GRAVEL and GRAVEL band were noted within WS103 (1.65-1.80 m bgl) and BH103 (3.50-4.60 m bgl.) A stiff to very stiff clayey SILT was identified in WS107 at 3.20-5.45 m bgl.
Bedrock	SOLID - >4.60 m bgl Sandstone bedrock was encountered within four exploratory hole locations from 4.60 m bgl - 6.70 m bgl. Deep rotary boreholes confirmed the presence of a weak to moderately strong SANDSTONE bedrock to a maximum depth of 29.00 m bgl.
Groundwater	Groundwater strikes were encountered during the ground investigation at 2.00 m bgl and 3.10 m bgl. Initial monitoring visits indicate groundwater at depths between 0.80 m bgl and 4.80 m bgl however within the majority of locations groundwater is at a depth >2.00 m bgl.



2. E3P CONTAMINATION RISK ASSESSMENT

2.1. BACKGROUND

E3P has completed a Tier 1 Qualitative Contaminated Land Risk Assessment to determine the potential risk to human health, controlled waters and the wider environment. This assessment is documented in full within the E3P Geoenvironmental Site Assessment report and, for clarity, is summarised in the following sections of this document.

2.2. HUMAN HEALTH RISK SUMMARY

The E3P Tier 1 Qualitative Human Health Risk Assessment identified concentrations of the following determinants at or above the screening criteria for the assessment of no unacceptable degree of risk to human health:

- ✳ Naphthalene
- ✳ Benzo(b)Fluoranthene
- ✳ Benzo(a)Pyrene
- ✳ Dibenzo(a,h)Anthracene
- ✳ TPH C16-C21
- ✳ TPH C21-C35
- ✳ Carbazole.

The identified elevated concentrations have primary exposure pathways related to soil ingestion (TPH), dermal contact and ingestion (PAH), and indoor vapour inhalation (naphthalene and carbazole).

The chronic risk to human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed landscaping and public open space to remove any potential for direct exposure to impacted soils.

Naphthalene has been identified within one isolated location on site (WS109 at 0.80 m bgl) and presents a risk of vapour inhalation. This material is currently capped by hardstand and therefore does not present a risk to current site users. As the proposed development comprises residential apartments, this material will require delineation and removal in its entirety from the footprint of the buildings to render the site suitable for residential development. The materials would likely be suitable for retention within areas of Public Open Space (POS).

TPH C16-C21 and TPH C21-C35 have been identified in one location on site (WS108 at 5.60 m bgl), however the pathway for these compounds is dermal contact and ingestion and given the depth of the identified impact (>5.00 m bgl), it is unlikely that this will pose a future risk to the proposed development in terms of human health. As such it is not considered that further works in this area are required; during remediation and enabling works further investigation within this area should be completed to confirm it is not part of a wider hydrocarbon plume.

Carbazole above the limit of detection was identified within WS111 at 0.80m at a concentration of 0.80 mg/kg.



Carbazole is a non-threshold substance and is a white, crystalline solid. It has a characteristic odour. It is a product of incomplete combustion of organic matter and occurs in petroleum, coal, peat, crude oil and coal tar. There is no toxicological data available to inform the preparation of robust site-specific risk-based assessment criteria that would model the potential for ingress of vapour to indoor air.

The US national library for medicine confirms:

"Carbazole released to air will also be in or on particles that eventually fall to the ground. It is expected to be broken down by sunlight, depending on environmental conditions. It will not move into air from moist soil and water surfaces."

If released to soil, carbazole can have high to no mobility based upon a Koc range of 114-4980, with most values suggesting low mobility to immobility. Volatilisation from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 1.16×10^{-7} atm-cu m/mole. Carbazole is not expected to volatilise from dry soil surfaces based upon its vapour pressure.

It is accepted that carbazole is a non-threshold substance, however, it will be encapsulated in soils with a temperature in the region of 10°C, furthermore given that it is highly unlikely to move into the ambient air via a vapour phase migratory pathway from a soil or water there cannot be a complete pollutant linkage in this instance.

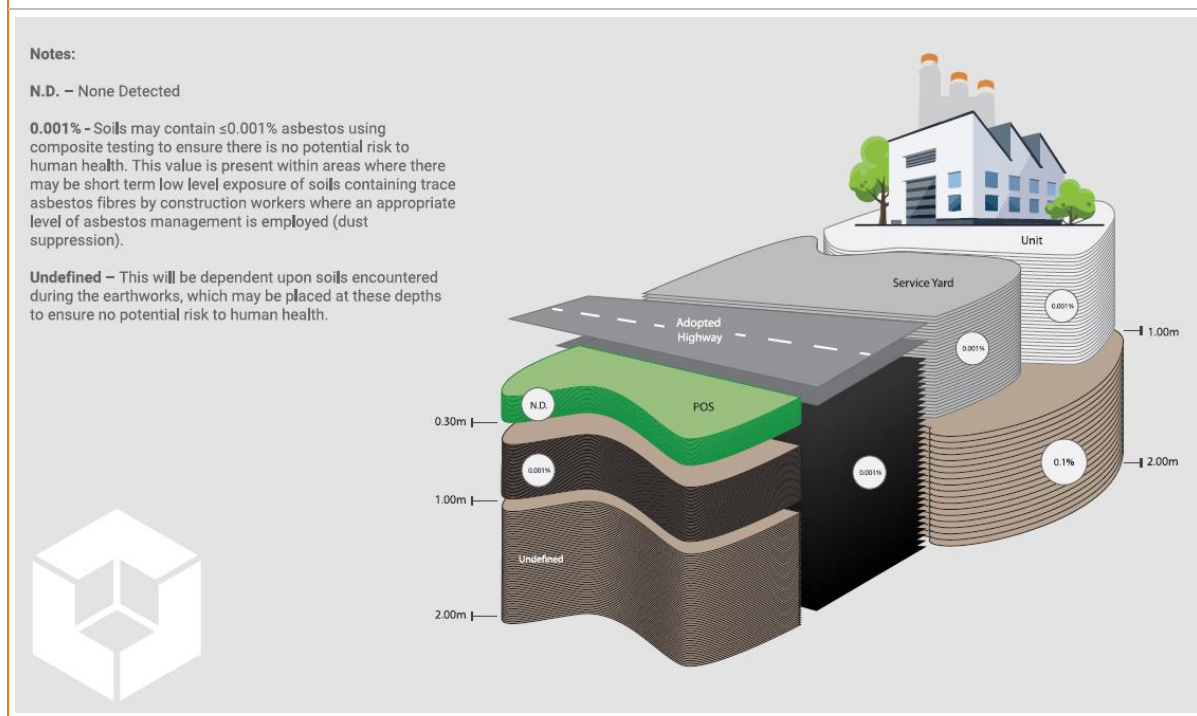
The recorded concentration is marginally above the limit of detection for the analytical method.

Carbazole can also be banded with dibenzofuran due to the absence of a GAC. Based on the threshold of 230 mg/kg, the concentrations within WS111 are not considered to be exceeding and will not present a risk to future end-users.

Asbestos was identified as a potential contaminant based on the historic site use however no asbestos was identified within the 8 samples analysed and no visual ACM was noted during the intrusive works. During remediation and enabling works, further testing of Made Ground will likely be required to confirm the findings of the ground investigation. Should any ACM be identified, this should be analysed and either appropriately placed on site in line with the E3P Asbestos Conceptual Site Model (see Figure 4.1) or removed from site by a licensed waste contractor.



FIGURE 2.1 ASBESTOS CONCEPTUAL SITE MODEL



All proposed landscaped areas within the development are to be installed with a 300 mm chemically suitable cover system, which will ensure that future site users will be at no unacceptable risk from the identified contaminant exceedances.

It is concluded that the site will be suitable for the proposed mixed-use development subject to the completion of the supplementary assessments and the following build-phase mitigation items:

- ✳ Further testing and validation of Made Ground soils to ensure that all materials are suitable for retention on-site or whether they can be placed in areas of low sensitivity during the site enabling works.
- ✳ Further groundwater monitoring to ensure there is no unacceptable degree of risk to controlled waters.
- ✳ Delineation, excavation, treatment and disposal of naphthalene impacted materials and subsequent testing to confirm the suitability of materials for retention on-site or removal off-site.
- ✳ Use of potable water supply infrastructure that will be compliant with United Kingdom Water Infrastructure Risk (UKWIR) assessment criteria following a post-remediation UKWIR assessment.
- ✳ Construction of a 450mm clean cover system with capillary break layer to all areas landscaping in accordance with the detailed methodologies herein.



2.3. CONTROLLED WATERS CONTAMINATION RISK SUMMARY

A Tier 1 Controlled Water Risk Assessment was completed by E3P as part of the E3P Geo-Environmental Site Assessment, the findings of which are summarised as follows:

- ✳ The direct comparison of groundwater samples recovered from dedicated monitoring wells has identified elevated concentrations of Selenium and TPH Aliphatic C21-C35 within one location (WS108) which exceed the screening criteria for the Drinking Water Standards (DWS).
- ✳ Elevated TPH Aliphatic C21-C35 within WS108 are considered to be associated with the hydrocarbon impacted SAND deposits. The CL:AIRE *Petroleum Hydrocarbons in Groundwater* guidance document shows the mobility ranking of TPH carbon bandings; TPH Aliphatic C21-C35 are not included however TPH Aliphatic C16-C21 are considered to have a very low sorption ranking and potential mobility ranking, and overall relative mobility in groundwater assessed as being very low. Given the elevated TPH bandings identified in the groundwater analysis it is considered they will have low mobility so are unlikely to migrate. The groundwater samples were obtained using a low flow technique, and it is recommended further monitoring is completed across the site to understand if there is site wide impact.
- ✳ It should be noted that the elevated concentrations of selenium and TPH Aliphatic C21-C35 are typically considered to be of low mobility.
- ✳ Given the absence of any notable receptors within proximity to the site, the low mobility of the identified contaminants which exceed DWS screening criteria, there is considered to be a low risk to controlled waters however further groundwater monitoring should be completed to confirm these findings.

2.4. GROUND GAS

Ground gas monitoring has been completed and the full assessment is summarised within the Ground Gas Addendum Report (Ref:15-175-R4-1, dated February 2022). The assessment was completed in accordance with the methodology outlined within BS8485:2015+A1:2019, utilising the results of the ground gas monitoring surveys to calculate a tentative gas screening value (GSV). The GSVs for the monitoring positions are summarised in Table 2.1.

TABLE 2.1 GAS RISK PROFILE AND LOCATION

LOCATION	MAX CO ₂ (% v/v)	GSV (l/hr)	MAX CH ₄ (% v/v)	GSV (l/hr)	CLASSIFICATION
Made Ground					
WS105	0.10	0.0001	0.10	0.0001	CS1
WS108	2.10	0.0021	0.10	0.0001	CS1
WS109	2.50	0.0025	0.10	0.0001	CS1
WS111	2.50	0.0025	0.10	0.0001	CS1
Drift					
WS103	0.10	0.0036	0.10	0.0036	CS1
BH102	0.10	0.0001	0.10	0.0001	CS1
BH103	0.10	0.0001	0.10	0.0001	CS1

The GSV has been compared to the criteria outlined within BS8485:2015+A1:2019 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.



Ground gas monitoring suggests that the site can be classified as CS1, and it is considered that ground gas protection measures will not be required.

Limited monitoring has been completed within WS105 due to the presence of a vehicle on the location, further monitoring will be completed in due course and the ground gas risk assessment subsequently updated.

2.5. POTABLE WATER SUPPLY INFRASTRUCTURE

A UKWIR assessment identified elevated concentrations of potentially volatile/soluble hydrocarbon compounds therefore based on the current ground conditions barrier pipe will be required for the proposed potable water supply. It will be necessary to delineate the impacted soils where present at locations that could potentially impact the potable water infrastructure with subsequent robust validation testing to confirm the post-remediation ground conditions.

A post remediation UKWIR assessment will be required to confirm the conditions following remediation as the site materials will vary from the current site conditions. If unacceptable concentrations remain where they pose a risk to the potable water supply post-remediation, then potable water infrastructure should be constructed in accordance with a suitably robust risk assessment and design compliant with UKWIR.



3. SITE REMEDIATION AND ENABLING WORKS

3.1. REMEDIATION OPTIONS APPRAISAL

A remediation options appraisal has been completed in accordance with the principals as set out within Environment Agency publication Land Contamination: Risk Management (LC:RM)(updated May 2020).

The LC:RM requires that the following tiered assessments are followed to ensure sufficiently detailed and robust appraisal of remediation options to inform the selection of the preferred approach and utilisation of the correct technologies to promote safe and sustainable land remediation:

- ✿ Identification of feasible remediation technologies;
- ✿ Detailed evaluation of viable options; and,
- ✿ Selection of appropriate remediation option.

3.2. DETERMINATION OF SUFFICIENCY OF INFORMATION

Prior to the commencement of the tiered assessment of remediation options, it is a requirement to assess the sufficiency of available information and validity of the risk-based assessment on which the remediation options appraisal is based.

Intrusive ground Investigation works completed to date is considered sufficient in order to fully understand the risks to future end users, controlled waters and the wider environ. However, due to the access limitations and the site conditions, the ability to gather further detailed information is considered required as part of the remediation and enabling works.

3.3. REQUIREMENT FOR REGULATORY CONTROL

The LC:RM requires that due consideration be given to the following key issues which will impact the appropriate selection of suitable remediation options.

- ✿ Requirement for regulatory permits.

The proposed remediation works may be covered by a specific Environmental Permit, it is considered that the processes as outlined below will be applicable to the project.

The processing of recycled aggregates will be completed using LAPC Part B licensed plant with the appropriate deployment notification to the local authority prior to commencement of works. All materials that are recovered as recycled aggregate will be compliant with the requirements of the WRAP protocol and the E3P validation testing requirements and as such would not be deemed to be a waste material.

Where necessary, operations as outlined within the remediation enabling works rationale summarised in this report may be subject to regulation using the appropriate environmental permit, standard rules exemption and materials management plan, to be created in accordance with version 2 of the CL:AIRE Definition of Waste: Code of Practice (DoW CoP).

It is noted that if material is to be imported utilising the CL:AIRE DoW CoP from an alternative development site, then only chemically certified, clean, naturally occurring material can be transferred.

The MMP will be created with due consideration of all proposed remediation and enabling works operations prescribed within this document and will be undertaken by a qualified person with a signed declaration submitted to the EA prior to reuse of materials on the site.



The importation of material for use within the proposed construction of a development platform will be subject to the compliance with the E3P protocol for the importation of materials as set out within the specification for material import included within Appendix V of this report.

3.4. REMEDIATION TECHNOLOGY

Considering the site-specific conditions, including the nature of the identified impacts, the geology and the objectives of the remediation, the most-appropriate soil remedial technologies are considered to be:

- ✳ Validation of soils during works to show that all residual soil concentrations are below the remediation targets for the protection of human health, controlled waters and the wider environment.
- ✳ Hotspot removal and delineation of soils impacted by naphthalene within the locality of WS109.
- ✳ Further investigation and additional groundwater sampling within the area of WS108 should be completed to confirm the identified TPH impact at 5.60 m bgl is not part of a wider hydrocarbon plume.
- ✳ Further testing of Made Ground to confirm the absence of asbestos.
- ✳ Removal of geotechnically unsuitable Made Ground, backfilled with suitably engineered granular material to mitigate the potential for future settlement.
- ✳ Provision of a capillary break layer and chemically suitable 450mm clean cover system within all areas of landscaping and public open space.

It is considered that these technologies and methodologies will address the identified active pollutant linkages, as detailed in the following subsections.

3.5. CONTAMINANTS OF CONCERN (COC)

3.5.1. PAH, NON-VOLATILE HYDROCARBON (PETROLEUM RANGE) COMPOUNDS

The human health risk drivers for the carcinogenic PAHs and TPHs CoC are:

- ✳ Direct contact with the soil source by future on-site residents; and
- ✳ Ingestion of impacted soils by future on-site residents.

Therefore, a cover system is considered to be an appropriate remediation technique to address these impacts, as the installation of a cover system to unsurfaced areas of the site will sever the pathway of contact for human health receptors. A cover system is not considered to be required in future hardstanding areas or beneath buildings, as it can reasonably be assumed that the presence of a hardstanding will prevent direct contact.

3.5.2. ASBESTOS

The human health risk driver for asbestos is:

- ✳ Inhalation of dust fibres by future on-site residents and adjacent residents



Asbestos has not been identified during the ground investigation however given the significant historic developments on site, there is potential for asbestos fibres to be present within the Made Ground matrix on site.

Further testing of Made Ground soils should be carried out during remediation works to ensure there is no unacceptable risk from asbestos fibres on site. If identified on-site, ACM-impacted soils must be managed to ensure no airborne fibre release during construction or placement of impacted material in such a manner as to ensure no future exposure risk.

If any visible pieces of asbestos-containing material are identified during the site remediation and enabling work, this material must be dealt with in strict accordance with the Control of Asbestos Regulations (CAR) 2012, UK Waste Management Legislation and the Environmental Protection Act 1994. Due to the close proximity of adjacent buildings, asbestos in air monitoring in accordance with HSG248 may be required to confirm that no asbestos fibres have been generated from the enabling works activities.

Should off-site disposal be required, then additional asbestos quantification and waste classification testing should be undertaken to ensure that it is classified correctly and disposed of at a suitably licensed facility.

3.5.3. LOCALISED NAPHTHALENE IMPACT

The human health risk driver for the volatile CoC, naphthalene, is:

-  Inhalation of vapours by future on site residents

The delineation, excavation, and removal of all impact soils with subsequent validation testing of the resulting excavation will demonstrate removal of contaminant source.

The excavated impacted material can be subject to on-site ex-situ treatment with validation testing utilised to demonstrate options for future re-use.

Where material is deemed unsuitable for retention and re-use, it will need to be removed and disposed of at a licensed treatment facility.

3.5.4. TPH (ALIPHATIC) C21-C35

The human health and controlled waters risk drivers for the petroleum hydrocarbon CoC are:

-  Migration into controlled waters, secondary A aquifer, within the drift geology beneath the site.
-  Migration into controlled waters, principal aquifer within the underlying bedrock geology.

Further groundwater monitoring is required during remediation and enabling works to confirm there is no unacceptable risk to controlled waters.



3.6. IDENTIFICATION OF FEASIBLE REMEDIATION OPTIONS

3.6.1. OBJECTIVES

The remediation works must be completed in a safe and sustainable manner that ensures that the post remediation condition of the site poses no unacceptable risk to controlled waters or the wider environs. The developed Conceptual Site Model must ensure no complete pollutant linkage to ensure successful implementation.

The remediation works must be completed in a manner that promotes sustainable re-use of material in a manner that minimises waste and maximises retention of material on-site.

The works should be designed and implemented in a manner that ensure no risk to an identified receptor during the works in terms of odour, air quality or noise impact.

Works should be designed, planned and implemented in a manner that ensures full compliance with all pertinent waste management and environmental permit legislation.

3.6.2. AVAILABLE TECHNOLOGIES

Potential remedial technologies that can be applied in order to remediate the identified contaminants of concern are summarised in Table 3.1, below. The remedial techniques considered would potentially break any source-pathway-receptor linkages, thereby reducing the risk to human health from vapour inhalation to acceptable levels.

TABLE 3.1 SOIL REMEDIATION TECHNOLOGIES

REMEDIAL TECHNOLOGY	CLASSIFICATION	APPLICATION	MEDIUM	LINKAGE ELEMENT AFFECTED
Capping	Containment	In situ	Soil	Pathway interruption
Electro-remediation	Physical	In situ / ex situ	Soil	Removes source
Soil washing	Physical	Ex situ	Soil	Source management
Soil vapour extraction	Physical	In situ	Soil	Removes source
Ex-situ bioremediation	Biological	Ex situ	Soil	Removes source
Thermal desorption	Thermal	Ex situ	Soil	Removes source
Vitrification	Thermal	In situ	Soil	Removes source / breaks pathway
Stabilisation / Solidification	Chemical	In situ / ex Situ	Soil	Pathway Interruption
Excavation and offsite disposal	Civil Engineering	Ex situ	Soil / groundwater	Removes source
Enhanced Bioremediation	Chemical / Biological / Natural attenuation	In situ	Soil / groundwater	Removes source / breaks pathway



REMEDIAL TECHNOLOGY	CLASSIFICATION	APPLICATION	MEDIUM	LINKAGE ELEMENT AFFECTED
Monitored Natural Attenuation	Natural attenuation	In situ	Soil / groundwater	Pathway interruption / eventual removal of source
Vacuum Enhanced Recovery	Physical / Chemical	In situ	Soil / groundwater	Removes source / breaks pathway
Air sparging / Biosparging	Physical / Biological	In situ	Soil / groundwater	Removes source / Pathway interruption
In situ oxidation	Chemical	In situ	Soil / groundwater	Removes source / Pathway interruption

3.6.3. SELECTION OF TECHNOLOGY OPTIONS

Several remedial technologies have been considered in addressing the contaminant linkages of concern identified at the site, as summarised in Table 3.2, overleaf.

In order to assess which of these technologies are most viable for this particular project, each technology has been reviewed on the basis of applicability, permissibility, cost, timescale and acceptability (including sustainability).

A combination of remediation solutions and technologies will be required to address and treat the numerous contamination issues identified on this site.

Aspects of sustainable remediation are also included within the review element of applicability.

Sustainable remediation is, 'the practise of demonstrating, in terms of environmental, economic and social indicators, that the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a balanced decision-making process', (as defined within 'A Framework for Assessing the Sustainability of Soils and Groundwater Remediation', produced by Sustainable Remediation Forum UK, dated March 2010).



TABLE 3.2 ASSESSMENT OF REMEDIATION TECHNOLOGIES APPLICABILITY

REMEDIAL TECHNOLOGY	APPLICABILITY	REGULATORY APPROVAL / PERMITRY	COST	TIME-FRAME	SCORE	SUITABILITY COMMENT
Capping	5	5	5	5	20	Essential remediation solution to remove direct exposure pathways.
Electro-remediation	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Soil washing	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Soil vapour extraction	1	1	1	1	4	Land to be remediated by excavation for geotechnical and geoenvironmental purposes meaning such a solution is limited in terms of viability.
Ex-situ bioremediation	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Thermal desorption	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Vitrification	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Stabilisation / Solidification	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Excavation and offsite disposal	5	5	1	5	16	Limited by cost being prohibitive. Small quantities of material that cannot be treated will be removed. Likely to form one aspect of the remediation approach.
Enhanced Bioremediation	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Monitored Natural Attenuation	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.



REMEDIAL TECHNOLOGY	APPLICABILITY	REGULATORY APPROVAL / PERMITRY	COST	TIME-FRAME	SCORE	SUITABILITY COMMENT
Vacuum Enhanced Recovery	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Air sparging / Biosparging	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.
In situ oxidation	0	0	0	0	0	Technique unlikely to treat identified contaminants of concern in an efficient manner.



3.7. SUMMARY OF PREFERRED REMEDIATION OPTIONS

Based on the options appraisal, it is considered that the following combination of remediation technologies provides the most sustainable, viable and economic solutions that will ultimately result in the successful remediation for the site:

- ✦ **Capping** of site with a suitable certified clean cover system comprising 150mm topsoil and 450mm subsoil will remove any future direct exposure pathways to future end users.
- ✦ **Excavation and off site removal** of hazardous materials which cannot be treated will be required, this operation needs to be limited to materials that cannot be treated on-site to promote sustainability and ensure viable regeneration.
- ✦ **Excavation of hotspot materials** for placement in areas of low sensitivity or removal off-site.



3.8. OVERVIEW OF WORKS

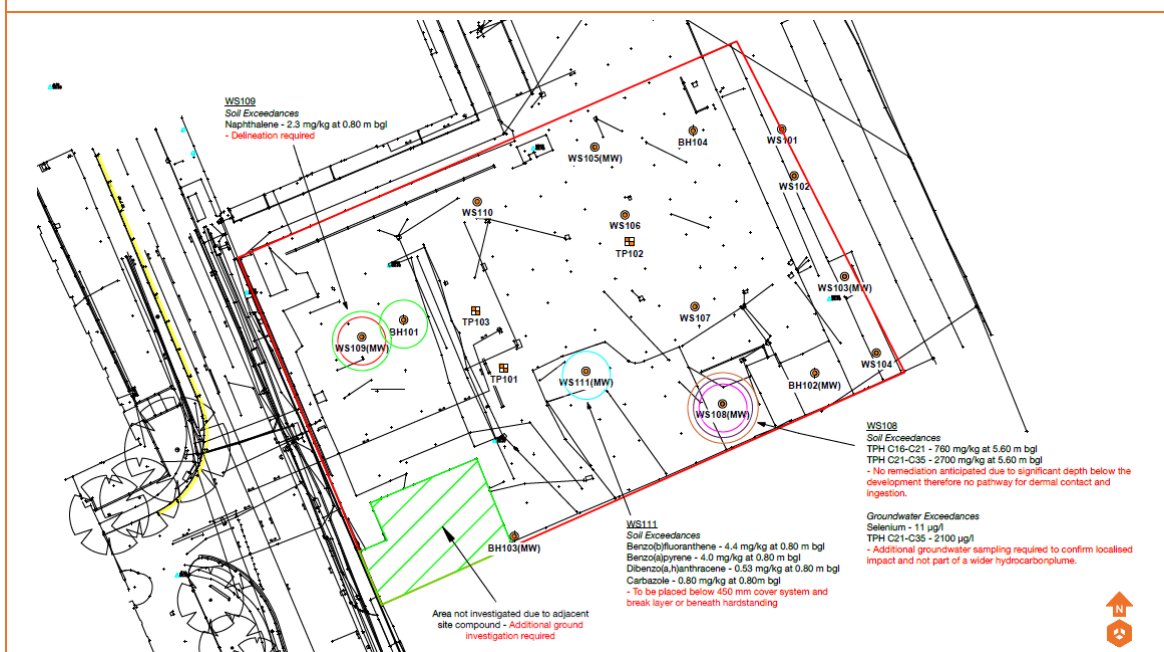
Prior to the commencement of works on site, the contractor must establish all necessary plant, equipment and site welfare facilities as is necessary to complete the contract within the agreed timescales to the rationale as outlined in the following subsections.

For the avoidance of any doubt, the proposed operations as set out herein document the required performance objectives and validation sampling protocols; however, the specific methods of work deployed to ensure the remediation objectives are achieved in a compliant manner on site will be the responsibility of the appointed contractor.

RE-1 – Pre-commencement Supplementary Site Investigation

Following the removal of hardstanding and concrete slabs, supplementary investigation and soil sampling is recommended in localised areas where previous investigation was limited, particularly in the west of the site and where the adjacent site compound prevented access. A snapshot of Drawing 15-175-015 (included in Appendix III) indicates the areas where the previous investigation was limited.

FIGURE 3.1 LOCATION OF RECOMMENDED ADDITIONAL SITE INVESTIGATION



Following removal of the existing hardstanding, mechanically excavated trial pits will be advanced with additional chemical analysis of the soils completed to confirm no unacceptable risk to human health and controlled waters.

If any yet unidentified contamination is identified, this will be the subject of further investigation including laboratory analysis and subsequent assessment of risk within the context of the agreed parameters. Where a theoretical risk to either human health, controlled waters or the wider environs is identified, appropriate remediation works are to be instigated by the placement of clean cover systems to break the pathway or delineation and source removal where required.



RE-2 – Pre-commencement Regulatory Compliance

Prior to the commencement of any works on site, all reports relating to the assessment of risk to contaminated land should be submitted to the regulatory authorities to gain written approval.

All relevant Standard Rules Permits should be registered with the EA.

The LAPC Part B Notification for the deployment of mobile crushing plant should be implemented prior to the establishment of equipment on site.

If the proposed volume of soils to be reused (excluding crushed materials) exceeds the parameters of the Standard Rules Permit, a CL:AIRE Materials Management Plan (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-impacted soil or groundwater); however, should any previously unidentified contamination be encountered, the contractor must either notify E3P and, if appropriate, relevant regulators of their intention to complete a minor works operation or arrange for the deployment of the appropriate environmental permit for the specified operation.

RE-3 – Environment and Nuisance Control

Management of all works is required to ensure that no environmental nuisance is created through dust emissions, noise or vibration levels.

All works are to be completed in a manner so as not to create any structural risk to the adjacent highways.

Temporary works are to be implemented as necessary to support excavations throughout the duration of the works.

In the event that a complaint is made in respect of dust emissions, noise or vibration levels, remedial measures and a programme of ongoing monitoring should be agreed with the local authority and implemented on-site.

RE-4 – Risk to Infrastructure

Site works should be completed in a manner that ensures no risk of disturbance to the adjacent infrastructure.



RE-5 – Site Clearance Operations

General site clearance and provision of welfare, offices and site security are to be determined as per the contract requirements.

There is no vegetation currently present on-site, however, if encountered, roots should be grubbed out in their entirety and the resulting void backfilled with suitably engineered fill.

As part of the site clearance operations all previous monitoring wells will be removed in their entirety and the resulting void backfilled with bentonite to ensure no future potential migration pathways.

RE-6 – Further Investigation into Elevated TPH within Groundwater

Elevated TPH Aliphatic C21-C35 identified within WS108 are considered to be associated with the hydrocarbon impacted SAND deposits.

Additional groundwater monitoring is required to further assess the previously identified TPH impact to confirm that there is a low risk to controlled waters. The additional monitoring should be carried out over multiple visits using a low flow technique.

A watching brief will be completed during the turnover of this area of the site. Additionally, further trial pits within the area and sampling of shallower deposits will be completed to ensure no further TPH impact is present.

RE-7 – Delineation, Excavation and Treatment of Potential Asbestos Impact

Asbestos has not been identified during the ground investigation however given the significant historic developments on site, there is potential for asbestos fibres to be present within the Made Ground matrix on site.

Further testing of Made Ground soils should be carried out during remediation works to ensure there is no unacceptable risk from asbestos fibres on site. If identified on-site, ACM-impacted soils must be managed so as to ensure no airborne fibre release during construction or placement of impacted material in such a manner as to ensure no future exposure risk.

If any visible pieces of asbestos-containing material are identified during the site remediation and enabling work, this material must be dealt with in strict accordance with the Control of Asbestos Regulations (CAR) 2012, UK Waste Management Legislation and the Environmental Protection Act 1994. This process should be completed under strict controls to be devised and employed by the nominated contractor to ensure no potential for fibre release into the ambient air. Due to the close proximity of adjacent buildings, asbestos in air monitoring in accordance with HSG248 may be required to confirm that no asbestos fibres have been generated from the enabling works activities.

The contractor must ensure that all personnel working on site are trained in the identification of ACM and the risks associated with impacted soils.

Should off-site disposal be required, then additional asbestos quantification and waste classification testing should be undertaken to ensure that it is classified correctly and disposed of at a suitably licensed facility



RE-8 – Delineation, Excavation, Treatment and Disposal of Naphthalene Impacted Materials

During the E3P investigation, elevated Naphthalene was identified in WS109 at 0.80 m bgl. This location should be treated as a localised hotspot, with soils delineated, excavated and validated during remediation works.

A watching brief should be completed during remediation works to monitor the area where naphthalene impact has been identified to ensure there is no further visual or olfactory evidence of wider contamination.

In the event that any as yet unidentified contaminant is identified, this will be the subject of further investigation including laboratory analysis and subsequent assessment of risk within the context of the agreed parameters. Where a theoretical risk to either human health, controlled waters or the wider environs is identified, appropriate remediation works are to be instigated.

Material deemed to be impacted through either visual or olfactory observations or as a result of notable PID readings (> 50 ppm) will be excavated and stockpiled on an impermeable membrane. The membrane will be placed upon a clay containment bund and covered to negate the risk of soils leaching and dispersal of any odours and/or vapours.

An E3P engineer will regularly monitor the stockpiled material with a PID to determine the need for boundary monitoring (albeit not anticipated). This material will then be subject to detailed laboratory analysis to determine the suitability for reuse or the requirements for off-site disposal.

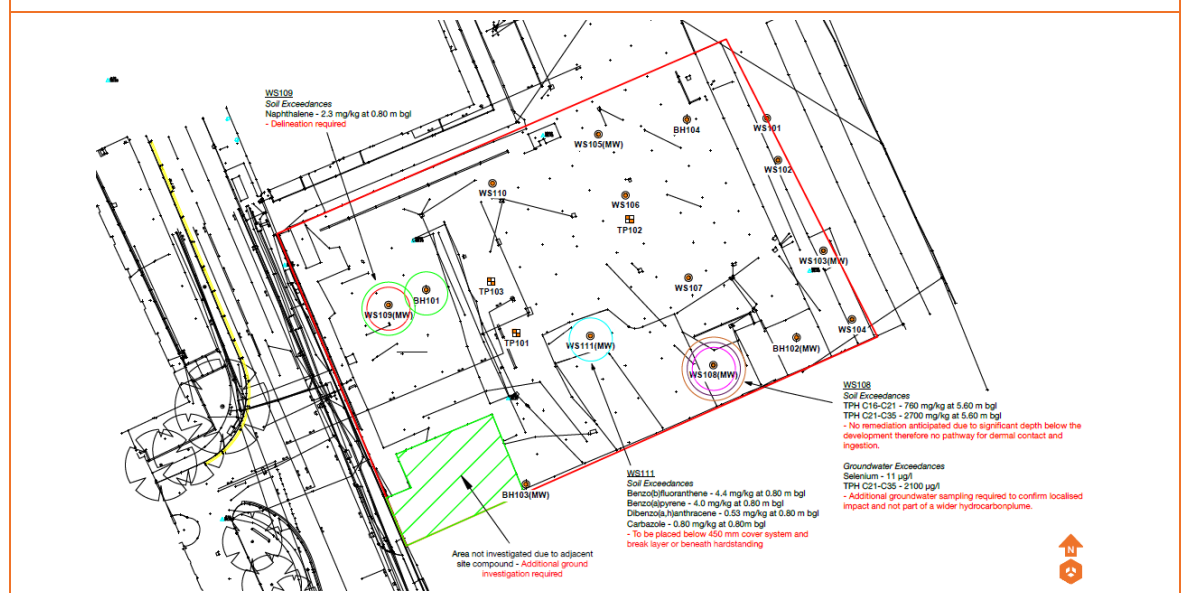
Upon completion of the delineation and excavation, the sides and base of the resulting void(s) where impacted material is present will be chemically validated to confirm that no impacted materials remain in situ. Validation samples will be collected at 10 linear metre centres from the side and base of the excavation. The results of this validation testing will be directly compared to the site-specific remediation targets (as defined within Appendix III of this report) to demonstrate that no unacceptable level of risk to human health, controlled waters or the wider environment remain.

Should further elevated concentrations of naphthalene be identified within either the hotspot delineation works or site won Made Ground then further investigation and risk assessment will be completed. There may be a requirement to complete further delineation and removal of materials. Following assessment and further laboratory analysis appropriate mitigation or remediation measures will be put in place.

The location of know naphthalene impacted soils (circled red) are shown in Figure 3.2.



FIGURE 3.2 LOCATION OF IDENTIFIED NAPHTHALENE IMPACT



RE-9 – Excavation, Breaking and Processing of All Above- and Below-Ground Structures

Obstructions, relict foundations, concrete slabs and infrastructure (apart from live services) are to be removed from the areas of proposed development in their entirety.

Artificially hard materials should be broken out and crushed. Stockpiles will be made, validation testing undertaken, and site-won material reused on-site where required. Materials will be processed as per the specifications provided in Section 5 using licensed plant.

The E3P drawings denote the extent of known historic features with obstructions; however, it will be the contractor's responsibility to remove all obstructions.

Obstructions encountered within the near-surface soils will be chased to their full depth and removed; if not possible, the obstruction must be surveyed with the location communicated to E3P, the client and the developer.

Where natural soils are present at a relatively shallow depth, extreme care should be taken to ensure that the natural cohesive deposits remain undisturbed with a full reduced-level survey to be completed to map the depth of filled/processed material.

It is anticipated that given the substantial depths of Made Ground identified in some areas, a full depth turnover may not be viable.

Where a full depth Made Ground turnover is not completed, these areas should be surveyed, with the locations communicated to E3P, the client and the developer. Across the site, and in particular within these areas, the proposed pile locations will require proof drilling to confirm there are no obstructions which would prevent the piles reaching full depth.

RE-10 – Cut-And-Filling of Made Ground to Development Levels

The Made Ground is noted to be present to substantial depths in some areas of the site (> 2 m). Where the proposed enabling works levels require the current landform to be cut, extreme care should be taken so as not to disturb the underlying stratum prior to the placement of the appropriate platform, in compliance with the E3P Geotechnical Specification.

Where the development levels require material to be filled, site derived Made Ground must be sorted in a controlled manner prior to replacement, in accordance with the requirements of this specification for the intended land use.

The maximum dry density must be determined in laboratory conditions utilising UKAS-accredited testing before the commencement of filling and compaction works. In-situ density testing is required to demonstrate compliance with the E3P Geotechnical Performance Specification.

RE-11 – Construction of Temporary Cover Layer

The site is to be prepared in a manner that will facilitate a piled foundation solution, as such a temporary cover layer will be constructed using locally-won recycled concrete aggregate.

As a minimum this will comprise:

-  Proof rolling of the subgrade to ensure a California bearing ratio (CBR) > 3%; and
-  Placement of certified 6F2 in accordance with structural engineer specification (thickness to be confirmed) to be rolled and compacted to ensure a CBR > 5%.

RE-12 – Replacement of Materials, Geotechnical Engineering Requirements

Material is to be backfilled in strict compliance with the E3P Geotechnical Engineering Specification as presented in detail within Section 5 of this report, which generally requires the reinstatement and compaction criteria presented in Table 3.3.



TABLE 3.3 GEOTECHNICAL ENGINEERING WORKS SCHEDULE

Land Use	Construction Requirement	Requirement
Footprint of Proposed Structure (2 m on All Elevations)	Pile Foundation	Backfill using general method compaction to CBR of 5%.
	Vibro-Stone Column	Particle size distribution (PSD confirmed as < 125 mm with no more than 10% fines (0.63 micron). Or Compaction to achieve > 95% of the laboratory determined maximum dry density (DD) with < 5% air void ratio. CBR > 6% with suitable pile mat. PSD testing of backfill material at 1 sample per 2000 m ³ to confirm.
	Traditional Spread Foundation	Ensure no disturbance of natural soil at shallow depth.
Highways	Adopted Estate Road/Drainage	Manual of Contract Documents for Highways Works (MCHW) Series 600 ensuring CBR > 5% in subgrade (engineered fill).
Driveways	Private Drives and Car Parking	Method compaction to CBR > 5%.
Gardens and Public Open Space	N/A	Method compaction to ensure no settlement.

RE-13 – Importation of Bulk Fill

Where there is a net shortfall of material required to achieve the proposed ground levels, it will be necessary to import natural inert soils and aggregate as per the engineering requirements (Section 5).

Imported material must be certified as suitable for use in strict accordance with the E3P chemical and geotechnical performance criteria (See Section 5) and in conjunction with the required duty of care notes and waste transfer exemption.

If recycled aggregates are imported, then laboratory testing should be completed to demonstrate compliance with the Waste and Resources Action Programme (WRAP) protocol.

Where inert soils are imported, laboratory testing should be completed in accordance with the requirements of the pertinent environmental permit (i.e., U1 Standard Rules) or CL:AIRE MMP for the reuse of clean, naturally occurring soils.



RE-14 – Preparation of Landscaped Areas for Cover System

As part of the remediation works, landscaped areas will be prepared in a manner that will facilitate the placement of the clean cover system during the development phase of the works. The preparation of the areas requiring clean cover is critical in ensuring delivery of the site in a manner that will ensure no risk to the proposed end-users.

Where Made Ground is deemed unsuitable for retention in a landscaped area, the area will be subject to a reduced-level dig to remove unsuitable material to a minimum depth of 450 mm below finished level or verified natural stratum (whichever is the shallower) with a capillary break layer at the base.

Excavated soil will be stockpiled pending the results of the appropriate validation testing (to be completed in accordance with this specification) prior to reuse in an area of no sensitivity or, where necessary, this material will be removed from the site in accordance with UK waste management legislation.

The placement of certified subsoil and topsoil will be completed as part of the developer works/build-phase mitigation plan. All landscaped areas where a cover system is required will be subject to independent validation.

RE-15 – Provision of Subsoil

Chemical analysis of the natural drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas with the exception of drift deposits noted to contain hydrocarbon impact; however, further chemical validation samples will be required.

The use of the natural clay soils will also be dependent on the requirements for the site as there is significant depths of Made Ground encountered across the majority of the site therefore the cut/fill works to 'win' the subsoil may be significant. Therefore, dependent on the final requirements for the proposed cut/fill, it is deemed possible to reuse natural materials that are cut as part of the wider earthworks or through a soil inversion (regulated by an MMP) to generate the required volumes of material.

If a soil inversion is not within the scope of the development works, and no site-won subsoil is available, there will be a requirement to import suitable material for use within the proposed development.

The landscaped areas will require depth validation to satisfy the requirement of the Local Planning Authority in order to demonstrate that the appropriate thickness has been provided as a growing medium. As per Manchester City Council's Planning and Contaminated Land Technical Guidance document, all landscaped areas require a minimum of a capillary break layer, 300mm subsoil and 150mm topsoil. Areas where specific vegetation types are to be planted may require deeper cover systems to provide adequate growing medium (~450mm-900mm) which are outlined in the MCC Technical Guidance document.



RE-16 – Provision of Topsoil

No material that would be deemed suitable for use as topsoil is present on-site and as such there will be a requirement to import suitable material for use within the proposed development.

Topsoil will require testing in line with the schedule present within Section 3.5 and Table 3.2.

The landscaped areas will require depth validation to satisfy the requirements of the CML in order to demonstrate that the appropriate thickness has been provided.

RE-17 – Independent Validation: Watching Brief

Given the site history and potential contamination sources identified within the ICSM, a degree of uncertainty remains with regard to the potential for as yet unidentified contamination impact within the near-surface soils and groundwater.

It will therefore be necessary to instigate the site-wide remediation and enabling works under the supervision of a suitably qualified and independent specialist. The specialist is required to attend site as and when appropriate to monitor works, record ground conditions and fully investigate all potential sources of as yet unidentified contamination.

RE-18 – Waste Soils Surplus to Requirements

In the event that a surplus of excavation material is present on-site, this, in most cases, will be deemed to be a waste in accordance with the Waste Framework Directive (Article 3(1) Waste Framework Directive 2008/98/EE). The waste producer – but ultimately, the landowner – is responsible for the compliant disposal of such materials.

A formal waste classification assessment must be undertaken, irrespective of any future options or considerations for those materials that will be removed from the site. Waste classification should only be made following the Environment Agency *Technical Guidance WM3 – Guidance on the Classification and Assessment of Waste*.

To remove the surplus material from the site it will either need to be sent to a disposal site (landfill), to a permitted treatment facility or, dependent on the waste classification assessment, it may be suitable for use on a permitted land improvement or restoration operation.

Subject to suitability, these soils can be transferred to the receiving site, subject to an approved permit or materials management plan following guidance in the CL:AIRE *Definition of Waste: Code of Practice*.



RE-19 – Validation of Materials for Potable Water Supply Infrastructure

A contaminant risk assessment, completed in accordance with the UKWIR assessment framework identified elevated concentrations of potentially volatile/soluble hydrocarbon compounds that necessitate the use of protected water supply pipework.

All materials where organic hydrocarbon impact is identified at concentrations above the UKWIR assessment criteria for a polyurethane pipe within the proposed locality of potable water supply infrastructure should be delineated and removed by the remediation contractor under the supervision of the geoenvironmental consultant.

Validation sampling should be completed at 10 m chainage at depths of 0.75 m and 1.50 m within the locality of the potable supply pipes where impacted material is removed, with samples analysed for all pertinent volatile and semi-volatile hydrocarbons and, where necessary, chlorinated/halogenated compounds.

Upon successful remediation of all impacted materials, the post-remediation validation testing will be reviewed by a qualified person to inform an updated UKWIR assessment to be reviewed and approved by the statutory adoption authority.

If unacceptable concentrations remain following remediation, then potable water infrastructure should be constructed in accordance with a suitably robust risk assessment and design compliant with UKWIR.

Where imported material is required to construct the potable water infrastructure pipework, this material will need to comply with the requirements of UKWIR pipework thresholds for the specified pipework. For the avoidance of doubt, the PE thresholds are presented in Section 9.2. Failure to meet the required specification may necessitate further remedial works.

RE-20 – Remedial Verification Report

Collation of information relating to site clearance, chemical testing, remedial works, remedial verification, material movements and waste transfer documentation is required, where appropriate.

Complete remedial validation is to be reported in line with regulatory guidance. This will include a detailed risk assessment. The report will be submitted to the local authority for approval following completion.



3.9. VALIDATION SAMPLING PROTOCOL

In accordance with the current requirements of the regulatory authorities, validation samples will be collected from all materials that are to be subject to movement under the protocols outlined within this remediation and enabling works strategy, or for materials to be imported onto site to facilitate the proposed residential development.

Upon removal of the hotspot of unsuitable Made Ground in the northern sector, validation samples will be collected from the base (two samples) and sidewalls (four samples) of the excavation to reasonably demonstrate no residual impact to the underlying strata.

Soil samples destined for chemical analysis will be collected at regular intervals in appropriate sampling containers. All samples will subsequently be stored in cooled boxes prior to submission to a UKAS/MCERTS accredited laboratory.

All samples will be collected using appropriate personal protective equipment (PPE) and sampling equipment, which will be cleaned at each sampling location.

A detailed copy of E3P Ltd sampling methodology, QA procedures and laboratory chain of custody forms will be documented within the site records and presented with the final validation report for the site.

Where the material is found to contain concentrations of potential contaminants at levels in excess of the site-specific screening criteria (as detailed within Appendix III), E3P 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 sampling frequency for materials to be managed under the remediation strategy is presented within Table 3.4.

TABLE 3.4 SPECIFICATION OF CHEMICAL VALIDATION LABORATORY ANALYSIS

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Site-Generated		
Site-Generated 6F2	1 Sample per 1000 m ³	A/B/C/D
Site-Won MADE GROUND General Backfill	1 Sample per 250 m ³ where visual and/or olfactory impact is identified	G
Site-Won MADE GROUND General Backfill	1 Sample per 1000 m ³	A/B/C/D
Site-Won MADE GROUND General Backfill	1 Sample per 2000 m ³	I
Site-Won Natural Backfill	1 Sample per 2000 m ³	A/B/C/D
Site-Generated Subsoil (450 mm Garden Cover)	1 Sample per 250 m ³	A/B/C/D
Site-Generated Topsoil Cover (150 mm Garden Cover)	1 Sample per 50 m ³	A/B/C/D
Hotspot Validation Samples	1 Sample per 10 m of linear excavation to base and sidewall	E/G
Imported		
6F2	1 Sample per 1000 m ³	A/B/C/D
Subsoil Greenfield Source	1 Sample per 200 m ³	A/B/C/D



MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
(150 mm Landscape Cover)		
Subsoil Brownfield Source (150 mm Landscape Cover)	1 Sample per 50 m ³	A/B/C/D
Topsoil Greenfield Source (150 mm Landscape Cover)	1 Sample per 200 m ³	A/B/C/D
Topsoil Brownfield Source (150 mm Landscape Cover)	1 Sample per 50 m ³	A/B/C/D
General Engineering Fill (Class 1 and 2 Soil)	1 Sample per 1000 m ³	A/B/C/D

Notes

Suites of Analysis:

- A. Speciated PAH.
- B. Speciated TPH (C5-C35).
- C. Asbestos (ID).
- 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.

All analysis prescribed above to be completed by UKAS-accredited laboratory.

3.10. REMEDIATION CONTRACTORS SITE MANAGEMENT AND RESPONSIBILITY

The appointed remediation contractor will take full and overarching responsibility for all methods of work required to complete the site remediation and enabling operations to ensure the delivery of the site and the completion of the objectives in a safe, legislatively compliant manner that ensures no pollution to the subject site or the wider environs.

For individual remediation operations as set out within this performance specification, the contractor will provide site-specific methods of work for individual operations pertaining to the removal and treatment of contaminated liquids and soils. For each and every operation as set out herein, the contractor will provide a written methodology of works to be supplied to the supervising geoenvironmental engineer prior to the instigation of operations on site.

The site manager will be responsible for documentation of each day's activities with a full recorded schedule of works completed and corresponding site-specific method statements that have been utilised to ensure the completion of the task to the required standard.



4. MATERIALS MANAGEMENT AND LEGISLATIVE COMPLIANCE

The processing of recycled aggregates will be completed using LAPC Part B licensed plant with the appropriate deployment notification to the local authority prior to commencement of works. All materials that are recovered as recycled aggregate will be compliant with the requirements of the WRAP protocol and the E3P validation testing requirements and as such would not be deemed to be a waste material.

A U1 Exemption will be registered for the site, which allows the reuse of up to 5000 T of prescribed material within construction, with up to 25,000 T of material permissible to be reused in the construction of roads. It should be noted that only 1000 T of material described as sand, stones or clay soil classified as waste can be reused with a U1.

A T5 Exemption, allowing for the screening and recovery of up to 5000 T of permissible material for subsequent reuse in construction will also be registered.

All materials that are recovered under the WRAP protocol, U1 or T5 exemptions must be analysed to demonstrate that they are both chemically and structurally suitable for use within the context of the development.

The relevant LAPC, U1, T5 and WRAP licences, exemptions and protocols provide the legislative framework for material compliance during the site remediation and enabling works to be completed by the specialist contractor under the supervision or E3P.

Where necessary, operations as outlined within the remediation enabling works rationale summarised in this report may be subject to regulation using the appropriate environmental permit, standard rules exemption and materials management plan, to be created in accordance with version 2 of the CL:AIRE *Definition of Waste: Code of Practice (DoW CoP)*.

It is noted that if material is to be imported utilising the CL:AIRE DoW CoP from an alternative development site, then only chemically certified, clean, naturally occurring material can be transferred.

If required, the MMP will be created with due consideration of all proposed remediation and enabling works operations prescribed within this document and will be undertaken by a qualified person with a signed declaration submitted to the EA prior to reuse of materials on the site.

The importation of material for use within the proposed construction of a development platform will be subject to the compliance with the E3P protocol for the importation of materials as set out within the specification for material import included within Appendix IV of this report.



5. ENVIRONMENTAL MONITORING AND VALIDATION

5.1. SITE MANAGEMENT

The tracking of materials will be based on the following hierarchy:

- ✚ The principal contractor will have the responsibility for setting out areas of the site on the basis of the contract specification.
- ✚ Operatives will have instructions only to excavate and to emplace materials in specified areas as assigned by the site manager/foreman.
- ✚ The site manager (employed by the principal contractor) will issue daily instructions to drivers regarding the placement of materials sourced from specific stockpiles or areas, ensuring that appropriate documentary evidence is collected that details which materials are going where and why.
- ✚ An E3P consultant, who will be in attendance as required, will:
 - Inspect the excavation areas and certify that the correct materials are being excavated;
 - Conduct spot checks on loaded vehicles to ensure compliance with this remediation strategy; and
 - Ensure that any loads that fail visual, olfactory or spot checks either remain on the vehicle or, if unloaded, are excavated and set aside. This material will be treated according to the recommendations of the E3P site engineer.
- ✚ E3P will conduct an audit of waste consignment notes. All material imported and removed from the site will have a duty of care/consignment notes, copies of which will be retained on-site by the site manager.
- ✚ Materials directly reusable will be incorporated into the earthworks, subject to operational conditions and phasing of excavations, in which case they will be stockpiled prior to final placement.

5.2. COMPLETION

Following the completion of the remediation works, a report will be compiled by the environmental consultant detailing all site enabling works undertaken, waste consignment notes, and all site investigations, laboratory test certificates and validation testing undertaken.

A certificate of completion of earthworks should be included within the report which should then be issued to the local authority for their approval.

E3P considers that with the adoption of the above best practices the site can be safely redeveloped. The site enabling works process and presence of any residual contamination (if this is the case) should be recorded for future reference by landowners/occupiers. Future development at the site where this may result in penetration of new areas of hardstanding should be subject to no-less-stringent measures with respect to assessment and, where appropriate, monitoring, than those set out herein.



5.3. MITIGATION OF RISK FROM SOILS WITH ASBESTOS FIBRES

Asbestos has not been identified during the ground investigation however given the significant historic developments on site, there is potential for asbestos fibres to be present within the Made Ground matrix on site.

Further testing of Made Ground soils should be carried out during remediation works to ensure there is no unacceptable risk from asbestos fibres on site. If identified on-site, ACM-impacted soils must be managed so as to ensure no airborne fibre release during construction or placement of impacted material in such a manner as to ensure no future exposure risk. The following information has been included given the possibility that asbestos and ACM may be present on-site therefore mitigation measures will be required.

5.3.1. PRE-COMMENCEMENT WORKS

Prior to the commencement of works the following requirements must be satisfied:

- ✳ Induction of all people that will be involved with the proposed site works; and
- ✳ All methodologies must be agreed upon by all parties involved.

5.3.2. CONTROL, MONITORING AND REPORTING OF GENERAL AERIAL EMISSIONS FROM DUSTS AND PARTICULATES

DAMPING DOWN OF SOILS – MITIGATE PARTICULATE (DUST) EMISSION

During excavation, as outlined within the detailed working methodologies, soils will be regularly damped down using water to control the generation of dust (this may also comprise precipitation). The contractor will determine the best form of dust suppression to be used when a detailed programme has been issued.

If any previously unidentified asbestos-containing materials are identified, these should be dealt with in strict accordance with the *Control of Asbestos Regulations* (2012) and industry best practice as detailed in CIRIA 733.

GENERAL CONTROL OF DUST

The following control measures should be utilised to ensure that dust levels are kept to a minimum at all times:

- ✳ Where necessary, haul road, work areas and stockpiles will be damped down with water spray.
- ✳ The application of water to haul roads, work areas and stockpiles should be closely monitored by the resident engineer to ensure that soils are not saturated and, therefore, that the potential for water run-off is appropriately mitigated.
- ✳ Once completed, any stockpiles will be sealed by compacting at the surface.
- ✳ Vehicle speeds and movements on site will be kept to a minimum (< 5 mph) during civil excavation works to reduce the potential to generate dust.



PERSONAL PROTECTIVE EQUIPMENT (PPE)

In accordance with the HSE *Guidance Note em6: Asbestos Essentials, Personal protective equipment (including RPE)*, E3P recommend that all site operatives present within the work area where potential asbestos-impacted soils are being excavated are supplied with the following personal protective equipment:

Overalls:

- ✿ Disposable overalls.
 - Type 5 (BS EN ISO 13982-1) are suitable.
 - Cotton overalls hold dust and need specialist laundering.
- ✿ Waterproof overalls for outdoor work.
- ✿ Use oversized overalls - this will help to prevent ripping at the seams.
- ✿ If the cuffs are loose, seal them with tape.
- ✿ Avoid wearing a long-sleeved shirt as these are difficult to cover properly.
- ✿ Wear the overall legs over footwear as tucking them in lets dust into footwear.
- ✿ Wear the hood over the RPE straps.

Failure to utilise and correctly employ PPE will result in immediate cessation of works. Works will not be permitted to recommence until the individual has undergone further training in the use of PPE or the individual is removed from the works area.

At this current time, with the levels of ACM identified within the soils, the above-listed PPE is not considered to be required for all site personnel during the entire management of these soils.

When handling asbestos-impacted soils during the enabling works, asbestos monitoring works should be conducted in accordance with, but not limited to, the following HSE legislation and guidance:

- ✿ *Health & Safety at Work Act 1974;*
- ✿ *The Control of Asbestos Regulations 2012;*
- ✿ CL:AIRE, 2016. *Control of Asbestos Regulations 2012 - Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance;*
- ✿ *Approved Code of Practice L143 Work with materials containing asbestos;*
- ✿ *Management of Health and Safety at Work Regulations 1999;*
- ✿ *HSE Guidance Note HSG248 Asbestos, the analysts guide to sampling and analysis;*
- ✿ *HSE Guidance Note HSG247 Asbestos: The licensed contractors' guide;* and
- ✿ *CIRIA 733 Asbestos in soil and made ground: a guide to understanding and managing risks.*



If required, air monitoring in accordance with HSG248 will be undertaken intermittently throughout the duration of the works at a frequency to be determined by the contractor, entirely dependent on whether asbestos-impacted soils are being handled at any given time. In general terms, during any one monitoring period, ten standard monitoring pumps will be run throughout the day, for the appropriate time period to achieve the required limit of detection. These slides will be analysed immediately by the on-site UKAS-accredited laboratory.

Once any monitoring has been analysed by the on-site UKAS-accredited laboratory, the results will be delivered to the resident engineer who will then follow the correct site procedure. The results will then be included within the verification report.



6. GEOTECHNICAL ENGINEERING SPECIFICATION

6.1. E3P GEOTECHNICAL ENGINEERING SPECIFICATION

The overarching philosophy of the site enabling works will be the delivery of the following:

- ✿ Preparation of plot footprint (+ 2 m on all elevations) to be suitable for a piled foundation solution.
- ✿ Preparation of a temporary cover layer using locally-won recycled concrete aggregate to the structural engineers specification.
- ✿ Engineer all areas of proposed adopted road and private drive to be compliant with the E3P Geotechnical Specification with CBR and elevation defined by the client.

In the event that it is not possible to prepare the site in a manner that will achieve the required foundation solution, the supervising engineer and client should be contacted at the first available opportunity.

The contractor should employ a suitably experienced engineer to be present on-site during these earthwork operations to ensure soil suitability, placement, compaction and testing is undertaken in accordance with this specification and to ensure that any unforeseen circumstances, such as adverse weather, do not compromise the earthworks process.

Works should be halted during periods of intermittent or prolonged rainfall to ensure the materials are not placed in a manner that would result in softening of either the formation or the newly placed material. It will be the contractor's responsibility to determine appropriate weather conditions and determine the suitability of works.

Particular attention must be given to variable weather conditions when re-engineering clay soils as a moisture content fluctuation ($\pm 2\%$) of the tolerable limit will result in an unacceptable degree of compaction loss.

6.2. LOCALLY WON FILL MATERIAL

It is proposed to upfill and level the site with material won from the development area. From the site-specific investigations undertaken to date, it is expected that the soil won from the processing of demolition material will be granular and cohesive.

Due to climatic weather conditions and variance in long-term differential settlement associated with even well-compacted granular soils, it is essential that the cut-and-fill process is well controlled, and materials are placed/compacted in accordance with this specification.

Where site-won materials are to be used as fill to achieve the required development platform, they must be compacted to ensure suitable compaction as stated in Table 6.2.

Materials should only be compacted when the actual moisture content is within 2% ($\pm$) of the optimum for the soil matrices as determined by laboratory bench testing.



6.3. CLASSIFICATION OF FILL MATERIAL

This specification should be read in conjunction with the following:

- ✳ The Manual of Contract Documents for Highway Works, Volume 1, Specification for Highway Works, Series 600, Earthworks as amended in February 2016; and
- ✳ BS 1377-1:2016 Methods of test for soils for civil engineering purposes. General requirements and sample preparation

6.3.1. GENERAL CLASSIFICATION

The contractor should ensure that all earthworks materials comply with Clause 601 of the *Specification for Highway Works* and shall fall into one of the following general classifications as defined in Table 6/1 of the *Specification for Highway Works*.

- ✳ General granular fill (Class 1);
- ✳ General cohesive fill (Class 2), excluding Class 2A and 2E; or
- ✳ Selected granular fill (Class 6).

6.3.2. PRE-COMMENCEMENT EARTHWORKS TESTING FREQUENCY / PERFORMANCE

To determine the geotechnical classifications of any material to be placed and compacted in layers, representative samples will be taken at a frequency of **1 per 2,000m³** and submitted for particle size distributions (PSDs). Maximum Dry Density and Natural and Optimum Moisture Content determinations.

To determine the geotechnical classifications of any cohesive material to be placed and compacted in layers, representative samples will be taken (following removal of any inclusions of oversize material, metal, timber, plastic, etc.) at a frequency of **1 per 1,000m³** and submitted for liquid and plastic limits, plasticity index and natural moisture content determinations. Organic matter determinations shall be prescribed at the discretion of the supervising consultant, dependent on visual observations.

Representative samples of all proposed backfill shall be taken at a frequency of **1 per 3000m³ (minimum 3nr)** and submitted for Dry Density / Optimum Moisture Content analysis using either a 4.5Kg or 2.5kg rammer to determine the optimum moisture content and maximum dry density for the engineering of structural fill.

For an unaltered fill material to be deemed suitable for use, the natural moisture content must be within 2% (+/-) of the optimum to achieve the required maximum dry density. Where the laboratory test indicates that the soil parameters are outside this requirement, stabilising agents should be added to assess suitability for use to the contractor's own design.



TABLE 6.1 E3P EARTHWORKS GEOTECHNICAL COMPACTION SPECIFICATION

SOIL/MATERIAL TYPE	CLASS	DESCRIPTION	COMPACTION EQUIPMENT	LAYER THICKNESS	ROLLER PASSES
Granular Fill (Sand and Gravel Matrices)	1 A	Sandy Gravel with some cobbles	> 5000 kg vibrating roller	225 mm	4
	1 B	Sand or Gravel of same grading size	> 5000 kg vibrating roller	250 mm	10
	1 C	Coarse gravels with many cobbles	> 5000 kg vibrating roller	400 mm	5
Cohesive Fill (Clay with Minor Sand and Gravel Component)	2 A	Wet Clay	> 1000 kg vibrating tamping roller (sheep foot only)	100–225 mm	3
	2 B	Dry Clay	> 5000 kg vibrating roller or 1400 kg tamping (trench roller)	225 mm or 125 mm	4 or 12
	2 C	Gravelly Clay	> 5000 kg vibrating roller or 1400 kg tamping (trench roller)	225 mm or 125 mm	4 or 12
	2 D	Silty/Sandy Clay	> 5000 kg vibrating roller or 1400 kg tamping (trench roller)	225 mm or 125 mm	4 or 12
Recycled Aggregate Crush (< 125 mm Well Graded)	6F2	Any combination of inert hard materials, other colliery spoil, or rock with substantial amounts of clay-like component	> 5000 kg vibrating roller	250 mm	6



6.3.3. USE OF FILL MATERIALS

In addition to any grading requirement, the maximum particle size of any fill material shall be no more than two-thirds of the compacted layer thickness except that cobbles having an equivalent diameter of more than 150 mm shall not be deposited within the restored surface level unless directed otherwise by the engineer. Un-burnt colliery spoil, pulverised fuel ash or furnace bottom ash shall not be used as a fill material.

6.4. GENERAL REQUIREMENTS

The contractor shall employ only plant and working methods that are suited to the materials to be handled and traversed. The contractor shall be responsible for maintaining the nature of the acceptable material so that when it is placed and compacted it remains acceptable in accordance with the contract.

For the purposes of this contract, the proposed earthworks requirements have been split into distinct end-use categories, with the corresponding requirements for the earthworks specification assigned to individual areas.

TABLE 6.2 COMPACTION/BACKFILL REQUIREMENTS

LAND USE REQUIREMENT	COMPACTION METHODOLOGY AND GENERAL PERFORMANCE CRITERIA
Piled Foundation	All plot footprint (+ 2 m) must be free of any deleterious elements, tree roots and obstructions > 150 mm. Where upfill is proposed, material is to be placed using method compaction specification to achieve a CBR as required by the developer for piling mat construction. Piling mat is to be placed and constructed in accordance with the approved geotechnical engineer's temporary works design.
Adopted Highways (+ 2 m from Back of Footpath)	<i>Method Compaction – MCHW Specification For Highway Works Series 600</i> is to be followed, with in-situ validation testing to meet requirement of adoptions authority. A CBR > 5% is required at subgrade formation (prior to placement of capping).
Estate Roads	<i>Method Compaction – MCHW Specification For Highway Works Series 600</i> is to be followed to achieve a CBR > 5%.
Gardens, POS and Other External Areas	Material is to be placed in layers not exceeding 300 mm and must be rolled using dedicated plant (no earth moving equipment) and in general compliance with the requirements of <i>MCHW Specification For Highway Works Series 600</i>.

Acceptability shall be determined in accordance with Table 6/1 of the *Specification for Highway Works*.

Laboratory testing for the purposes of determining acceptability and compaction requirements will be conducted by the engineer.



Haulage of material to embankments or other areas of fill shall proceed only with sufficient spreading and compaction.

Plant should only operate at the place of deposition to ensure compliance with Clause 612 of the *Specification for Highway Works*.

No excavated acceptable material or unacceptable material required to be processed, other than surplus to the requirements of the contract, shall be removed from the site.

Where the excavation reveals a combination of acceptable and unacceptable materials, the contractor shall carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. Unless otherwise described in the contract, classes of fill material required to be deposited separately shall be excavated separately without contamination by other classes of material.

The contractor shall make their own arrangements for the stockpiling of acceptable material, and unacceptable material to be processed, and for the provision of a site for this purpose.

The contractor shall ensure that they do not adversely affect the stability of excavations or fills by their methods of stockpiling materials, use of plant or siting of temporary buildings or structures.

Topsoil shall, wherever practicable, be used immediately after its stripping and, if not, shall be stored in stockpiles of heights not exceeding 2 m. Topsoil shall not be stockpiled for more than two years. Topsoil shall not be unnecessarily trafficked, either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

Excavations requiring backfilling shall remain open only for the minimum period necessary.

The contractor shall keep earthworks free of water, including:

- ✿ Arranging the rapid removal of water:
 - shed on to the earthworks; and
 - entering the earthworks from any source;
- ✿ Provide, where necessary, temporary watercourses, drains, pumping and the like;
- ✿ Discharge accumulated water and groundwater into the permanent outfalls of the drainage system where practicable; and
- ✿ Provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

The contractor shall carry out and maintain groundwater lowering or other treatment as required.

Where materials are designated either Class U1B or Class U2 (according to the *Specification for Highway Works*), the contractor shall carry out any special requirements for their handling. Where such materials are encountered during the progress of the works, the contractor shall make all necessary arrangements for their safe handling and disposal after consultation with the appropriate environmental authority.



6.4.1. CONSTRUCTION OF FILLS – HIGHWAYS

All fills shall be constructed:

-  In the locations as shown in the contract drawings to the lines and levels stated therein;
-  Of classes of material complying with this specification;
-  By deposition, as soon as practicable after excavation, in layers to meet the compaction requirements as required for each class of material as specified; and
-  To the requirements of this clause and any other requirements for fill in this specification.

Before commencing work on any area of fill, the contractor shall ensure that:

-  The base is sound and stable by excavating and removing any topsoil as soft subsoil;
-  Base layers are not exposed until the fill layer is ready for placement; and
-  Uncompacted material on the side slopes of previously backfilled zones shall be removed and benches of between 1.0 m and 1.5 m height cut in compacted fill immediately prior to deposition of the new fill to ensure that the new backfill placed against the slope is properly integrated.

Whenever fill is to be placed on surfaces inclined at 1 vertical to 7 horizontal or steeper, the surface shall be benched immediately prior to deposition of the fill in order to achieve horizontal basal surfaces. The benches shall be between 1.0 m and 1.5 m in height.

Areas of fill shall, unless otherwise permitted by the engineer, be constructed evenly over their fullest possible extent and the contractor shall carefully control and direct construction plant and other vehicular traffic uniformly over the area of compacted fill. The minimum plan dimensions of any one panel of backfilling shall be properly integrated with areas of previous backfilling. Damage by construction plant and other vehicular traffic shall be made good by the contractor with the material having the same characteristics and strength as the material had before it was damaged.

Temporary slopes within compacted and uncompacted backfill shall be formed at gradients that ensure stability.

6.4.2. CONSTRUCTION OF FILLS – ADOPTED HIGHWAYS, ESTATE ROADS AND CAR PARK

The contractor shall carry out compaction upon the materials that require to be compacted, as soon as practicable after deposition.

Compaction shall be either method as required for the classes of fill in Table 6/1 that require to be compacted.

The contractor shall obtain permission from the overseeing organisation before carrying out compaction requirements as listed in Table 6/1 for the class of material being compacted.

Method compaction shall be undertaken using the plant and methods appropriate to the compaction requirements as listed in Table 6/1 for the class of material being compacted.



Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account when assessing the amount of compaction required for any layer.

If more than one class of material is being used in such a way that it is not practicable to define the areas in which each class occurs, the contractor shall compact with plant operating as if only the material which required the greater compaction effort is being compacted.

If the results of field tests show densities that indicate the state of the compaction to be inadequate, then if this is due to failure of the contractor to comply with requirements of the contract, the contractor shall carry out such further work as is required to comply with the contract.

Refer to Clause 612/10 of the *MCHW Specification for Highway Works* for definition of plant to be used in accordance with these specified works.

The contractor will be responsible for assessing the class of fill in accordance with Table 6/1 of the *Specification for Highway Works*. Table 6/4 of the *Specification for Highway Works* should then be employed to assess the method of compaction to be employed. The test results and method statements shall be submitted to the consulting engineers for approval.



6.4.3. UNACCEPTABLE MATERIAL

The contractor is solely responsible for ensuring full and detailed analysis of all reported ground conditions and areas of risk in terms of the potential for unacceptable material to be present within the proposed earthworks. Limitations in the available information should be highlighted to the supervising engineer prior to the commencement of earthworks. The contractor is to make full and unequivocal arrangements to investigate the potential presence for unsuitable materials within the earthworks and construction of highway fill. All unsuitable materials are to be identified for removal in accordance with this specification.

Unacceptable material Class U1A shall be:

Material which does not comply with the permitted constituents and material properties of MCHW Table 6/1 and contract specific Appendix 6/1 for acceptable material; and;

Material, or constituents of materials, composed of the following unless otherwise described in contract specific Appendix 6/1:

- ✿ Peat, materials from swamps, marshes and bogs;
- ✿ Logs, stumps and perishable material;
- ✿ Materials in a frozen condition;
- ✿ Clay having a liquid limit determined in accordance with BS 1377: Part 2, exceeding 90 or plasticity index determined in accordance with BS 1377: Part 2, exceeding 65; and,
- ✿ Material susceptible to spontaneous combustion except unburnt colliery spoil complying with sub-Clause 15 of this Clause;(ii)unacceptable material

Unacceptable material Class U1B shall be:

Contaminated materials, including controlled wastes (as defined in the Environmental Protection Act 1990 Part IIA) whose level of contamination is above that given either in contract specific Appendix 6/14 or in contract specific Appendix 6/15, but excluding all hazardous wastes (as Volume 1 Series 600 Specification for Highway Works Earthworks W2 Amendment – February 2016 defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).3(02/16).

Unacceptable material Class U2 shall be:(i) hazardous waste (as defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive waste (as defined in the Radioactive Substances Act 1993).4(02/16).

Where required in contract, unacceptable material (other than Class U2) shall be processed by mechanical, chemical or other means to render the material acceptable for use in the permanent works in accordance with the requirements of Table 6/1 and contract specific MCHW Appendix 6/1.



6.5. EARTHWORKS MATERIAL TESTS

Prior testing of the potential sources of fill shall be undertaken by the contractor and submitted to the consulting engineers for approval. This testing shall include, but not necessarily be limited to, the compaction and backfill requirements detailed in Table 6.3.

TABLE 6.3 COMPACTION/BACKFILL REQUIREMENTS

LAND USE	COMPACTION METHODOLOGY and GENERAL PERFORMANCE CRITERIA				
Liquid and Plastic Limits	BS 1377: Part 2				
Grading	BS 1377: Part 2				
Uniformity Coefficient	Calculated from grading curve				
Moisture Content Multi-point moisture condition value (MCV) (to assess optimum moisture content).	BS 1377: Part 2				
Organic Matter (Maximum 2.5% Total Organic Content)	BS 1377: Part 3				
Water Soluble Sulphate	TRL Report 447 Test No 1				
Total Sulphate Content	TRL Report 447 Test No 4				
Earthwork In-situ Tests Subsequent to the filling and compaction of the material, a series of in-situ tests shall be undertaken to confirm the success of the compaction process. This testing shall include, but necessarily be limited to, the following: <table><tr><td>Test</td><td>Test Method</td></tr><tr><td>Plate Load Tests (Equivalent CBR of 5%)</td><td>BS 1377: Part 9</td></tr></table>	Test	Test Method	Plate Load Tests (Equivalent CBR of 5%)	BS 1377: Part 9	Clause 632 (BS 1377: Part 4)
Test	Test Method				
Plate Load Tests (Equivalent CBR of 5%)	BS 1377: Part 9				
Disposal of Materials The contractor shall be responsible for the safe disposal of any excess of unsuitable material found on the site.					
Proctor Compaction Testing	BS 1377: Part 4				



7. RECORD-KEEPING AND VERIFICATION

7.1. RECORD-KEEPING

During the course of the remediation and site enabling works, the on-site site manager will undertake the following record-keeping protocols:

- ✚ Detailed daily site diary including material movements;
- ✚ Sampling register, testing results, photographs, details of locations of hydrocarbon-impacted soils (drawings), details of hotspot removals, details of consignment notes of any hydrocarbon-impacted material that is required to be disposed of off-site; and
- ✚ Detailed surveys (volumes).

Record-keeping on site, in particular movements and analysis of specific material types, will be in the form of site diaries and a remediation excavation record. This record will remain on-site and will be completed by the site manager during the course of the remediation and site enabling works.

7.2. VERIFICATION

The records listed above will then be compiled into a validation report produced by E3P on completion of the remediation and site enabling works, clearly referencing the origin of the materials used and testing carried out to confirm its suitability for use, where required. E3P will also prepare an as-built development drawing clearly detailing the materials present on-site to be cross-referenced with the supporting validation documentation.

The validation report will include the following:

- ✚ Remediation strategy (including copies of confirmation from regulatory authorities agreeing criteria);
- ✚ Detailed surveys of all excavations and production of as-built drawings for the earthworks;
- ✚ Copy of consignment notes relating to the movement of wastes to a licensed waste management facility;
- ✚ Detailed drawings showing all sampling locations for both chemical and geotechnical testing;
- ✚ Chemical test results;
- ✚ Geotechnical test results;
- ✚ Details of qualified persons signed declaration; and
- ✚ Monitoring results if undertaken (e.g., asbestos in air, gas water).



8. CONTINGENCY PLAN

8.1. PREVIOUSLY UNIDENTIFIED CONTAMINANTS

Should significantly impacted material be encountered during the development, then it will be excavated and stockpiled on an impermeable material and sampled and tested for an appropriate range of determinants.

Once the laboratory analysis of the material is available, an assessment will be undertaken to determine whether it can be retained on site as part of the material management plan or whether it should be disposed of off site.

Depending on the nature of any such impact, it may be necessary to undertake validation testing of the excavation faces in order to demonstrate that no such materials are left in situ.



9. SECOND PHASE MITIGATION AND MANAGEMENT – BUILD PHASE

This document details the construction works that are required to ensure full compliance with the remediation strategy, Regulatory Authorities, Building Control and Warranty Providers;

The following should be implemented during the build phase of the development:

- ✚ Laboratory testing of the imported topsoil;
- ✚ Chemical validation of any additional subsoil imported for use within gardens;
- ✚ Placement of a capillary break layer beneath the clean cover system;
- ✚ Placement and validation of subsoil (clean material) in a 300mm layer within any landscaped areas where the material was not placed during the Remediation and Enabling works; and
- ✚ Placement and chemical validation of imported topsoil within all landscaped areas.

The validation protocols are presented within the E3P Remediation and Enabling Works Strategy and are presented below.

9.1. PLACEMENT OF COVER SYSTEM

The Remediation and Enabling Works Strategy for the site, concerning human health of the future site users include the provision of a chemically suitable clean material to be installed in all landscaped areas as stated in the Manchester City Council Planning and Contaminated Land Technical Guidance; the construction of the clean cover/placement of clean material shall consist of:

- ✚ Capillary break layer;
- ✚ 300mm subsoil; and
- ✚ 150mm topsoil.

Under the MCC technical guidance, if vegetation, shrubs or trees are included within the landscaped areas, specific requirements for the provision of growing medium and planting outlined in the technical document (Manchester City Council Planning and Contaminated Land Technical Guidance) should be adhered to. These have been summarised in Table 9.1 below.

TABLE 9.1 GROWTH MEDIUM ROOTING DEPTH FOR VARIOUS VEGETATION TYPES

VEGETATION TYPE	ROOTING DEPTH (mm)
Grass	450
Plants	450
Shrubs	600
Trees	900

Following the current requirements of the regulatory authorities, validation samples will be collected from all materials that are to be imported or re-used on-site to confirm the proposed development will pose no unacceptable risk to human health or the wider environment.



Subsoil and topsoil shall be free of any deleterious materials, such as buildings materials, timber, plastics etc. and conform to the requirements of BS 3882:2007.

Testing requirements for topsoil and subsoil are presented in Table 9.2.

TABLE 9.2 SPECIFICATION FOR SOIL TESTING

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Subsoil Greenfield Source (150 mm Landscape Cover)	1 Sample per 200 m ³	A/B/C/D
Subsoil Brownfield Source (150 mm Landscape Cover)	1 Sample per 50 m ³	A/B/C/D
Topsoil Greenfield Source (150 mm Landscape Cover)	1 Sample per 200 m ³	A/B/C/D
Topsoil Brownfield Source (150 mm Landscape Cover)	1 Sample per 50 m ³	A/B/C/D
General Engineering Fill (Class 1 and 2 Soil)	1 Sample per 1000 m ³	A/B/C/D

Notes

Suites of Analysis:

- A. Speciated PAH.
- B. Speciated TPH (C5-C35).
- C. Asbestos (ID).
- D. CLEA Inorganic Heavy Metals.



9.1.1. PROCEDURE FOR PLACEMENT OF CHEMICALLY SUITABLE COVER SYSTEM

Landscaped areas need to be backfilled with 300 mm chemically validated subsoil, with 150 mm topsoil overlaying this. Topsoil is required to be confirmed as chemically suitable prior to placement. Where subsoil is not placed during remediation and enabling works, E3P will be required to return to the site and undertake independent validation of the correct placement of subsoil.

The placement of 450 mm of clean material and capillary break layer will be undertaken during the build phase works of the project.

The placement of subsoil and corresponding validation will be documented within the Landscaping Validation Letters (to be issued on completion of the contractor's works).

If proposed utilities are to be placed within the cover system, the clean cover should be placed prior to installation of these utilities.

E3P will collect photographic evidence of the placement of 150 mm of certified topsoil and 300 mm of subsoil on completion of construction works. This element will also be checked by the Building Control Officer as part of the site completion.

The landscape validation procedure is detailed in Table 9.3.

TABLE 9.3 LANDSCAPE VALIDATION PROCEDURE

PROCEDURE	METHOD
Chemical Validation	Imported subsoil and topsoil will need to be chemically analysed to confirm suitability for use with the proposed cover system prior to installation and completion of the garden systems. E3P will issue an email to the appropriate party with an assessment of the chemical suitability of both subsoil and topsoil. If acceptable the materials can be installed to the required depth at which time the plot will be deemed complete following a validation procedure by a suitability qualified E3P engineer.
Trial Holes	Trial holes are deemed necessary for all landscaped areas given that the 300 mm cover system will need to be placed within all landscaped areas during the build phase.
Validation	Photographic evidence will be taken by E3P of the topsoil and subsoil placement demonstrating the depth of topsoil and subsoil and practical completion of works.
Validation Certificate	Once the photographs of the placement of topsoil (over the clean material) have been provided, E3P will issue a plot-specific validation certificate to demonstrate that the required subsoil and topsoil has been placed in the required landscaped areas along with the chemical analysis.
Completion Report	Upon completion of all landscaped areas within the development, a Completion Report will be issued providing the confirmation that all remediation requirements have been achieved.

Plate 1 provides an example of landscape validation photographs that will be required.



PLATE 1 EXAMPLE LANDSCAPE COVER SYSTEM VALIDATION

Plot No: 4 (Car Park Landscaping)

Depth of Strata (m bgl)	0.00-0.30	Validated TOPSOIL
Depth of Cover System Materials		Depth of Cover System Materials
		

Depth of Cover System at Ground Level and in Relation to Unit / Structure



9.2. POTABLE WATER SUPPLY – CONTAMINANT ASSESSMENT CRITERIA

Table 9.4 provides a summary of the threshold concentrations that must not be exceeded within remediated ground at pipeline depth in order to PE pipe works to be acceptable for the proposed development.

TABLE 9.4 PIPELINE SELECTION PE THRESHOLD CONCENTRATIONS

Contaminant Group	PE-threshold
Total VOC	0.5
Total BTEX And MTBE	0.1
Total SVOCs (Excluding PAH and those substances marked with an *)	2
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500
Phenols (From SVOC Analysis)*	2
Cresols and Chlorinated Phenols (From SVOC Analysis)	2
Ethers*	0.5
Nitrobenzene*	0.5
Ketones*	0.5
Aldehydes*	0.5
Amines	Fail

Upon completion of the remedial works a full UKWIR Risk Assessment should be undertaken.

END OF REPORT



APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the Client as indicated in Section 1.2.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information, it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.
8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.
10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.



APPENDIX II

GLOSSARY

TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	WTE	Water table elevation



m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	mAOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	SSRT	Site Specific Remediation Target
PSD	Particle Size Distribution	DD	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	Mc	Moisture Content
ρ	Bulk Density	GPR	Ground Penetrating Radar
NDP	Nuclear Density Probe	FFL	Finished Floor Level
LEL	Lower Explosive Limit	UKWIR	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	LOD	Limit of Detection



APPENDIX III

DRAWINGS

APPENDIX IV E3P REMEDIATION/ VALIDATION CRITERIA

HUMAN HEALTH REMEDIATION TARGETS – LOW-RISE RESIDENTIAL END USE

DETERMINAND	UNITS	WITHIN 600 mm COVER SYSTEM (GARDEN)	HARD STANDING AND >600 mm OF COVER	PUBLIC OPEN SPACE 300 mm COVER	PUBLIC OPEN SPACE > 300 mm	PATH- WAY
Arsenic	mg/kg	37 ⁽ⁱ⁾	40 ⁽ⁱⁱ⁾	79 ⁽ⁱⁱⁱ⁾	170 ^(iv)	1
Cadmium	mg/kg	11 ⁽ⁱ⁾	85 ⁽ⁱⁱ⁾	120 ⁽ⁱⁱⁱ⁾	532 ^(iv)	1
Chromium (Hexavalent)	mg/kg	6 ⁽ⁱ⁾	6 ⁽ⁱⁱ⁾	7.7 ⁽ⁱⁱⁱ⁾	220 ^(iv)	1
Lead	mg/kg	200 ^(vi)	310 ^(vii)	630 ^(viii)	1300 ^(viii)	1
Elemental Mercury	mg/kg	1.2 ⁽ⁱ⁾	1.2 ⁽ⁱⁱ⁾	16 ⁽ⁱⁱⁱ⁾	30 ^(iv)	2
Nickel	mg/kg	130 ⁽ⁱ⁾	180 ⁽ⁱⁱ⁾	230 ⁽ⁱⁱⁱ⁾	800 ^(iv)	1
Selenium	mg/kg	250 ⁽ⁱ⁾	430 ⁽ⁱⁱ⁾	1100 ⁽ⁱⁱⁱ⁾	1800 ^(iv)	1
Copper	mg/kg	2400 ⁽ⁱ⁾	7100 ⁽ⁱⁱ⁾	12,000 ⁽ⁱⁱⁱ⁾	44,000 ^(iv)	1
Zinc	mg/kg	3700 ⁽ⁱ⁾	40,000 ⁽ⁱⁱ⁾	81,000 ⁽ⁱⁱⁱ⁾	170,000 ^(iv)	1
Phenol	mg/kg	120 ^{(i)(xi)}	440 ^{(xiv)(xi)}	440 ^{(iii)(xi)}	440 ^{(iv)(xi)}	2
Naphthalene	mg/kg	2.3 ^{(i)(xi)}	2.3 ^{(xiv)(xi)}	1200 ^{(iv)(xi)}	1200 ^{(iv)(xi)}	2
Acenaphthylene	mg/kg	170 ^{(i)(xi)}	500 ^(v)	15,000 ^{(iii)(xi)}	29,000 ^{(iv)(xi)}	3
Acenaphthene	mg/kg	210 ^{(i)(xi)}	500 ^(v)	15,000 ^{(iii)(xi)}	29,000 ^{(iv)(xi)}	1
Fluorene	mg/kg	170 ^{(i)(xi)}	500 ^(v)	9900 ^{(iii)(xi)}	20,000 ^{(iv)(xi)}	1
Phenanthrene	mg/kg	95 ^{(i)(xi)}	500 ^(v)	3100 ^{(iii)(xi)}	6200 ^{(iv)(xi)}	3
Anthracene	mg/kg	500 ^{(i)(xi)}	500 ^(v)	74,000 ^{(iii)(xi)}	150,000 ^{(iv)(xi)}	3
Fluoranthene	mg/kg	280 ^{(i)(xi)}	500 ^(v)	3100 ^{(iii)(xi)}	6300 ^{(iv)(xi)}	3
Pyrene	mg/kg	500 ^{(i)(xi)}	500 ^(v)	7400 ^{(iii)(xi)}	15,000 ^{(iv)(xi)}	3
Benzo(a)Anthracene	mg/kg	7.2 ^{(i)(xi)}	11 ^{(ii)(xi)}	29 ^{(iii)(xi)}	49 ^{(iv)(xi)}	3
Chrysene	mg/kg	15 ^{(i)(xi)}	30 ^{(ii)(xi)}	57 ^{(iii)(xi)}	93 ^{(iv)(xi)}	3
Benzo(b)Fluoranthene	mg/kg	2.6 ^{(i)(xi)}	3.9 ^{(ii)(xi)}	7.1 ^{(iii)(xi)}	13 ^{(iv)(xi)}	3
Benzo(k)Fluoranthene	mg/kg	77 ^{(i)(xi)}	110 ^{(ii)(xi)}	190 ^{(iii)(xi)}	370 ^{(iv)(xi)}	3
Benzo(a)Pyrene	mg/kg	2.2 ^{(i)(xi)}	3.2 ^{(ii)(xi)}	5.7 ^{(iii)(xi)}	11 ^{(iv)(xi)}	3
Indeno(123-cd)Pyrene	mg/kg	27 ^{(i)(xi)}	45 ^{(ii)(xi)}	82 ^{(iii)(xi)}	150 ^{(iv)(xi)}	3
Dibenzo(a,h)Anthracene	mg/kg	0.24 ^{(i)(xi)}	0.31 ^{(ii)(xi)}	0.57 ^{(iii)(xi)}	1.1 ^{(iv)(xi)}	3
Benzo(ghi)Perylene	mg/kg	320 ^{(i)(xi)}	360 ^{(ii)(xi)}	640 ^{(iii)(xi)}	1400 ^{(iv)(xi)}	3
TPH C ₅ -C ₆ (aliphatic)	mg/kg	42 ^{(i)(xi)}	42 ^{(ii)(xi)}	42 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₆ -C ₈ (aliphatic)	mg/kg	100 ^{(i)(xi)}	100 ^{(ii)(xi)}	100 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₈ -C ₁₀ (aliphatic)	mg/kg	27 ^{(i)(xi)}	27 ^{(ii)(xi)}	27 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₀ -C ₁₂ (aliphatic)	mg/kg	130 ^{(i)(xi)}	130 ^{(ii)(xi)}	130 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₂ -C ₁₆ (aliphatic)	mg/kg	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	10,000 ^{(xiv)(xi)}	1
TPH C ₁₆ -C ₂₁ (aliphatic)	mg/kg	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	10,000 ^{(xiv)(xi)}	1
TPH C ₂₁ -C ₃₅ (aliphatic)	mg/kg					1
TPH C ₅ -C ₇ (aromatic)	mg/kg	70 ^{(i)(xi)}	370 ^{(ii)(xi)}	370 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₇ -C ₈ (aromatic)	mg/kg	130 ^{(i)(xi)}	860 ^{(ii)(xi)}	860 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₈ -C ₁₀ (aromatic)	mg/kg	34 ^{(i)(xi)}	47 ^{(ii)(xi)}	47 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₀ -C ₁₂ (aromatic)	mg/kg	74 ^{(i)(xi)}	250 ^{(ii)(xi)}	250 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2



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TPH C₁₂-C₁₆ (aromatic)	mg/kg	140 ^{(i)(xi)}	1800 ^{(ii)(xi)}	1800 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	1
TPH C₁₆-C₂₁ (aromatic)	mg/kg	260 ^{(i)(xi)}	1900 ^{(ii)(xi)}	1900 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	1
TPH C₂₁-C₃₅ (aromatic)	mg/kg	1000 ^{(xiv)(xi)}	1900 ^{(ii)(xi)}	1900 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	1
Asbestos	Fibres Volume Weight (%)	NFD	0.001%	NFD	0.001	4

Notes 1

NFD = No Fibres Detected

Asbestos will be screened visually on site by a qualified environmental consultant and where potential ACM is identified, representative samples will be subject to quantitative analysis of % volume by weight.

Should any ACM be identified within the soil matrices, further detailed % assessment would be required when the reported laboratory result exceeds the limit of detection for the analytical method at 0.01% by volume (weight).

Notes 2

Excludes matrices where free product is observed.

No viable exposure pathway beneath hardstanding and cover system.

Notes 3

Main exposure pathways: 1 = soil ingestion, 2 = vapour inhalation (indoor), 3 = dermal contact and ingestion, 4 = dust inhalation.

Abbreviations: GAC = general assessment criteria, n = number of samples, MC = maximum concentration, N/A = Not Applicable (no exceedance of assessment criteria), Loc of MC = location of exceedances.

- i. Value derived from LQM Sutable 4 Use Levels (S4ULs) for residential end use with plant uptake.
- ii. Value derived from LQM Sutable 4 Use Levels (S4ULs) for residential end use without plant uptake – these levels used below 600 mm cover system within residential gardens as soils will be present within a residential setting, yet soils will not be disturbed, and garden plants will not reach these soils.
- iii. Value derived from LQM Sutable 4 Use Levels (S4ULs) for public open space (POS) residential.
- iv. Value derived from LQM Sutable 4 Use Levels (S4ULs) for public open space (POS) park – these levels used below 300 mm POS cover system as soils will not be disturbed by any future site users and exposure to these soils will be similar to a park end use.
- v. Value derived from LQM Sutable 4 Use Levels (S4ULs) alongside assessment with WM3 to ensure that materials remaining on site do not exceed the WM3 toxicity criteria for hazardous waste.
- vi. Value derived from Category 4 Screening Levels (C4SL) for residential land use with homegrown produce.
- vii. Value derived from Category 4 Screening Levels (C4SL) for residential land use without homegrown produce.
- viii. Value derived from Category 4 Screening Levels (C4SL) for public open space (POS) residential.
- ix. Value derived from Category 4 Screening Levels (C4SL) for public open space (POS) park.
- x. Mercury – based on elemental mercury.
- xi. PAH and TPH levels used are for 1% SOM.
- xii. Xylenes based on p-xylene (o-xylene 2600 mg/kg, m-xylene 3500 mg/kg) and is capped by its solubility.
- xiii. Value derived from LQM Sutable 4 Use Levels (S4ULs) for residential end use with plant uptake due to the volatilisation risk.
- xiv. BTEX is not SOM-related due to inhalation pathway.



REMEDIATION TARGETS – COMPARISON OF GROUNDWATER / LEACHATE ANALYSIS WITH TIER 1 SCREENING LEVELS

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS ^{3,4,5}
		AA	MAC	
Arsenic	µg/l	50	–	10
Cadmium	µg/l	0.08-0.25	0.45-1.5	5
Chromium (VI)	µg/l	3.4	–	–
Chromium (III)	µg/l	4.7	–	50
Copper	µg/l	1	–	2000
Total Cyanide	µg/l	1	–	50
Lead	µg/l	1.2	14	10
Mercury	µg/l	–	0.07	1.0
Nickel	µg/l	4	34	20
Selenium	µg/l	–	–	10
Zinc	µg/l	10.9	–	–
pH		6–9		
Naphthalene	µg/l	2	130	10*
Anthracene	µg/l	0.1	0.1	
Benzo[b]fluoranthene	µg/l	0.00017*	0.017	
Benzo[k]fluoranthene	µg/l	0.00017*	0.017	
Benzo(a)pyrene	µg/l	0.00017*	0.27	
Indeno(123-cd)pyrene	µg/l	0.00017*	5*	
Benzo(ghi)pyrene	µg/l	0.00017*	5*	
Fluoranthene	µg/l	0.0063	0.12	
Benzo(ghi)perylene	µg/l	1.7–4	8.2–3	
TPH C5-C6 (benzene)	µg/l	10	50	1
TPH C6-C8 (toluene)	µg/l	74	–	700
TPH C8-C10 (Ethyl benzene)	µg/l	20	–	300
TPH C10-C12 (xylene)	µg/l	30	–	500
TPH C12-C16	µg/l	2	130	90 ⁵
TPH C16-C35	µg/l	50#	50#	90 ⁵
TPH C5-C6	µg/l	–	–	15000
TPH C6-C8	µg/l	–	–	15000
TPH C8-C10	µg/l	–	–	300
TPH C10-C12	µg/l	–	–	300
TPH C12-C16	µg/l	–	–	300



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS ^{3,4,5}
		AA	MAC	
TPH C16 – C21	µg/l	–	–	300**
TPH C21-C35	µg/l	–	–	300**
Tetrachloroethylene	µg/l	0.4	–	10
Trichloroethylene	µg/l	10	–	10
Trichlorobenzene	µg/l	0.4	–	–
Trichloromethane	µg/l	2.5	–	–
Dichloromethane	µg/l	20	–	200
Carbon Tetrachloride	µg/l	12	–	3
Vinyl Chloride	µg/l	–	–	0.3

Notes

Solubility <0.01µg/l

AA – Annual Average

MAC- Maximum Admissible Concentration

* Polyaromatic hydrocarbons (PAH) - Benzo(a)pyrene (BaP), Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the biota EQS or the corresponding AA-EQS in water

** There are no WHO Guideline Values for aliphatic fractions C16-C21 and C21-C35, therefore the guideline value for aliphatic fractions inclusive of C8-C16 (300µg/l) has been applied.

1. The Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations (2015)
2. Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)
3. Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances
4. Council Directive on the quality of water intended for human consumption (Drinking Water Directive)
5. WHO Guidelines for Drinking Water Quality. Third edition (2004)



APPENDIX V

E3P MATERIAL IMPORT CRITERIA

SITE OF IMPORTATION ADDRESS		E3P +44 (0) 161 707 9612 info@e3p.co.uk 
Client		
Main Contractor		
Earthworks Contractor		
Haulier		
Date of Planned Import		
Overview of Planned Material Import		
Material Source (Site of Origin) and Postcode		
Site Investigation Report	Report Title and Reference: Date: Information Supplied By:	
Reason for Generation of Excess Material at Site of Origin		
Chemical Test Results for Stockpile at Site of Origin	Date: Laboratory Certificate Ref: Organisation Responsible for Stockpile Sampling:	
Geotechnical Material Classification and Testing	Delete as Appropriate: Class 1 / Class 2 / Class 6 / Topsoil	
Pictures of Material Stockpile Pending Transportation	Delete as Appropriate: Yes / No	
Person or Organisation Responsible for Ensuring Quality Control at Site of Origin		
Quantity of Material to Be Imported (m³)		
Proposed Area of Deposition (Site of Reuse)		
Waste Exemption/Permit or CL:AIRE MMP		Delete as Appropriate: U1 Standard Rules / CL:AIRE MMP (Direct Transfer) / Bespoke



APPENDIX VI CONTRACTOR PRE- COMMENCEMENT CHECK SHEET

GEOTECHNICAL ENABLING WORKS PRE-START FORM

Prior to the commencement of any site remediation or enabling works, this form will be completed by E3P, in the presence of the appointed contractor, to ensure that all pertinent remediation and enabling works activities are fully discussed and understood.

Activity	Testing Responsibility	Contractors Method Statement Required (Y/N)	Comment/Action
Deployment of Environmental Permit			Ref No:
Deployment of LAPC Part B – Mobile Plant Permit			Ref No:
CL:AIRE MMP and Qualified Person Declaration			Ref No:
Identification of All Invasive Plant Species and Production of Eradication Plan with Appropriate Supervision by Specialist			Appointed specialist:
Removal of All Vegetation			Note disposal location:
Removal of All Root Bulbs and Root Networks			Note disposal location:
Identification of Contamination Hotspots, Removal of Material and Stockpile			Rationale:
Legislatively Compliant Procedure to Deal with Contamination Excavated from Hotspot			Rationale:
Processing and Recycling of Aggregate with Geotechnical and Chemical Validation Testing			Note stockpile location and anticipated volume:
Stockpiling of Subsoil and Certification of Suitability for Reuse			Stockpile location:
Decommission of All Redundant Drainage Infrastructure			
Decommission of All Former Interceptors			
Decommission of All Former Above- and Below-Ground Tanks			
Removal of All Asbestos to a Licensed Facility			
Engineering of Plots for Shallow Spread Foundation in Accordance with E3P Geotechnical Specification			Plot Numbers



Activity	Testing Responsibility	Contractors Method Statement Required (Y/N)	Comment/Action
Engineering of Plots for VSC in Accordance with E3P Geotechnical Specification			Plot Numbers.
Engineering of Plots for Pile Foundation in Accordance with E3P Geotechnical Specification			Plot Numbers
Engineering of Plots for Raft Foundation in Accordance with E3P Geotechnical Specification			Plot Numbers
Stockpiling of Topsoil and Certification of Suitability for Reuse			Stockpile location
Engineering of Highways Bulk Upfill in Accordance with E3P Specification with Compliant Validation Testing			Upfill specification
Engineering of Highways Subgrade in Accordance with E3P Specification with Compliant Validation Testing			Upfill specification
Engineering of Highways Capping in Accordance with E3P Specification with Compliant Validation Testing			Upfill specification
Cut-and-Fill the Development Site to Clients' Required Elevation with As-Built Survey			Required formation elevations



APPENDIX VII CONTRACTOR COMPLETION CHECK SHEET

GEOTECHNICAL ENABLING WORKS COMPLETION FORM

Upon completion of all site remediation and enabling works, this form will be completed by E3P, in the presence of the appointed contractor, to ensure that all pertinent geotechnical enabling works activities are complete or, where a deviation from the specification has occurred, all future limitations and issues are documented for the client's records.

Activity	Complete			Signature
	Yes	No	N/A	(initial)
Eradication of all invasive plant species				
Removal of all vegetation				
Removal of all root bulbs and root networks				
Stockpiling of topsoil and certification of suitability for reuse				
Stockpiling of subsoil and certification of suitability for reuse				
Stockpile all recycled aggregate with geotechnical and chemical validation testing				
Removal of all relict foundations and infrastructure in their entirety				
Decommission of all redundant drainage infrastructure				
Decommission of all former interceptors				
Decommission of all former above- and below-ground tanks				
Removal of all waste materials to a licensed facility				
Removal of all asbestos to a licensed facility				
Engineering of all plots for shallow spread foundation in accordance with E3P Geotechnical Specification				
Engineering of all plots for VSC in accordance with E3P Geotechnical Specification				
Engineering of all plots for pile foundation in accordance with E3P Geotechnical Specification				
Engineering of all plots for raft foundation in accordance with E3P Geotechnical Specification				
Engineering of highways bulk upfill in accordance with E3P Specification with compliant validation testing				
Engineering of highways subgrade in accordance with E3P Specification with compliant validation testing				
Engineering of highways capping in accordance with E3P Specification with compliant validation testing				
Cut-and-fill the development site to client's required elevation with as-built survey				



POST-REMEDIATION AND ENABLING LIMITATIONS

All and every deviation from the approved specification for works should be documented by the remediation and enabling works contractor below.



