Remediation and Enabling Works Strategy
Bennett Street, Manchester

Reference:15-974-R2-2
Date: January 2023

REMEDIATION AND ENABLING WORKS STRATEGY

Bennett Street
Manchester
M12 5NL

Prepared for:
Kellen Homes

Report Ref: 15-974-R2-2
Date Issued: January 2023

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EXECUTIVE SUMMARY

Site Address	Bennett Street, Manchester, M12 5NL
National Grid Reference	E 386189, N 397031
Site Area	6.08 Ha.
Background	E3P has been instructed by Kellen Homes to develop a remediation and enabling works strategy for the proposed residential development at the site located to the north of Bennett Street, Manchester. The E3P Remediation and Enabling Earthworks Strategy has been produced in due consideration of the multiple phases of geoenvironmental site investigation and contaminated land assessments previously undertaken by E3P on behalf of Kellen Homes.

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, trace asbestos fibres, TPH fractions and SVOC within shallow Made Ground deposits above Tier 1 thresholds. The shallow Made Ground is therefore not suitable for use within proposed "soft" areas, where a direct exposure pathway exists. All gardens will require the placement of a 600 mm chemically suitable cover system (comprising 450 mm subsoil and 150 topsoil) with a geotextile membrane break layer beneath to remove the exposure pathway and ensure no unacceptable risk to human health receptors. Where the Made Ground is < 600 mm below final garden levels, the cover system should only extend to the natural stratum to ensure adequate mitigation of all perceived risks. Asbestos fibres at quantification of <0.001% were identified within WS125 (0.50 m bgl). This material will require careful management and subsequent placement in an area of no future sensitivity in accordance with the E3P Developed Conceptual Site Model (CSM). SVOCs above the limit of detection (LOD) have been identified across the site within Made Ground. These detected compounds have been compared to the available Atkins ATRSK tables, and this indicates one exceedance at WS121. Dibenzofuran, carbazole, anthraquinone, 2-methyl naphthalene and 2,4-dimethylphenol do not have prescribed GAC values. As such, any presence has been considered a potential risk. In relation to SVOCs (including naphthalene), VOCs and TPH C10-16, these contaminants have primary exposure pathways related to vapour. The majority of the SVOC exceedances are identified in locations with elevated levels of volatile TPH residue within the soil matrix, which is attributed to be the source of the SVOCs. On review of the current site activities, it is considered highly likely that the original cobbles across the site are bounded by coal tar cement. Prior to the supplementary investigation, the cobbles had been lifted and removed. This recorded a reduction in TPH exceedances – as anticipated – as the source of TPH, the coal tar, has been removed.

	Concerning the mercury exceedances identified, WS123B, WS135 and WS136 In relation to mercury exceedances, for the majority of samples analysed, mercury was found to be non-volatile and therefore the risk can be mitigated through the construction and validation of suitable clean cover systems. Where samples could not be quantified, a theoretical vapour risk remains. To mitigate the residual risk from SVOCs and theoretical mercury vapour risk across the site, a provision for vapour membranes should be made for all proposed plots. This would remove the contamination pathway between source and receptor and mitigate the risk to the end-user against indoor vapour inhalation. The build phase specification and design will be given within the Build Phase Mitigation Plan, under a separate cover. Chemical analysis of the natural drift deposits has identified these soils to be acceptable for use as subsoil within any landscaping areas where no anthropogenic elements are present. There are no suitable sources of topsoil at the site. Localised, as yet unidentified 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, remediation action.
Controlled Waters Risk Assessment	Potential sources of mobile/soluble phase contaminant impact were identified at the site in the form of tanks, Made Ground and the site's historical use as a transport depot, printers and iron foundry. The results of the data review and Tier 2 qualitative risk assessment have allowed E3P to draw the following conclusions with respect to the risk to controlled waters: - There have been multiple phases of ground investigation, which has enabled reasonable characterisation of the pollution risk and potential to impact the critical receptors; - Low permeability cohesive clay deposits encountered beneath the site will inhibit the downward migration of contamination and offer protection to the underlying aquifers. - Site-wide heavy metal, PAH and isolated TPH exceedances have been recorded within leachate analysis and perched groundwater. This is considered to be associated with residual impact on shallow anthropogenic materials. All primary and secondary pollution sources have now been removed from the site in their entirety.

Controlled Waters Risk Assessment Cont..	• Within Black Brook, minor heavy metals (copper and zinc) and PAH (anthracene and fluoranthene) exceedances have been identified in comparison to EQS. However, significant exceedances of naphthalene and TPH (C10-C16) exceedances have been identified in comparison to the EQS. This indicates a minor heavy metal and PAH impact is present within the surface water feature, with a more significant TPH and naphthalene impact likely associated with the current and historical industrial activities in the wider area (off site). Further surface water testing should be undertaken up and downstream during remediation and enabling. • Within Corn Brook – identified as the primary receptor – minor exceedances of heavy metal (zinc and total cyanide) and PAH (naphthalene) exceedances have been identified in comparison the EQS. This indicates a minor heavy metal and PAH impact is present within the surface water feature, likely associated with the wider industrial activities in the area. Further surface water testing should be undertaken up and down stream of the site to confirm this. • No exceedances of determinant tested within the principal aquifer groundwater samples against DWS. • Relatively low-level exceedances of heavy metals and PAH were identified within BH202 and BH204 compared to EQS. Given the lack of active groundwater abstraction recorded within 1km of the site, low permeability of the overlying drift limiting vertical migration and low solubilities and concentrations of heavy metal and PAH recorded, there is considered to be no unacceptable risk to the underlying aquifer. • Black Brook is to be diverted as part of the proposed development and will be fully encapsulated, as such, it is not considered that Black Brook will be in hydraulic continuity with the site upon completion of these works. • Corn Brook is to remain untouched, at this stage, it is assumed that it is in hydraulic continuity with the site. As such, Corn Brook has been identified to be the critical receptor for controlled waters. • A full survey for Corn Brook is not currently available. However, it is likely that the culvert is sealed off from the site as such, not in hydraulic conductivity. A survey should be completed to confirm the condition of the Corn Brook culvert, with repairs made in areas of degradation and damage. Upon completion of this works it is considered that there will not be a direct contamination pathway between the site and surface water features, as such, no unacceptable risk of the controlled water receptor will be present. Further analysis of the surface water in Black Brook and Corn Brook should be undertaken as groundworks progress to ensure no future mobilisation of contaminants is caused, which may pose a risk to the watercourse.

Ground Gas	Sources of ground gas at the site include Made Ground, tanks and formerly infilled ponds. Ground gas monitoring suggests that the site can be predominantly classified as CS1, and in these areas, it is considered that gas protection measures against carbon dioxide and methane will not be required. However, due to the presence of site-wide residual SVOC impact within the soils across the site, provision for vapour membranes should be made for all plots.
Invasive Plants	None identified previously.
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. Initial assessments indicate that barrier pipe will likely be utilised at the site.

GEOTECHNICAL ASSESSMENT

Relict Sub-Structures	Significant relict substructures, infrastructure and materials deemed geotechnically deleterious are identified. All such materials will require removal from beneath proposed structures and infrastructure to the depths and extents as defined within this specification.
Adverse Ground Conditions	All potentially infilled ponds and historical features where deleterious/putrescible material is identified should be located and subject to the necessary remediation works. Soft clays will require removal in order to facilitate VSC foundations.
Proposed Foundations	During a phase of cut-and-fill enabling works to create a developable platform, all below-ground obstructions will require grubbing out to the base of the Made Ground to enable the construction of proposed plots. The site is due to be lifted by circa 0.50 m bgl to alleviate flood risk. As such, deeper foundations will likely be required and an earthworks specification should be utilised to ensure adequate compaction of materials to support the proposed loadings. Due to the levels likely increasing across the site, it is likely that proposed low-rise plots in this area would be constructed using a combination of foundation solutions including VSC to support strip or trench-fill foundations. Where high-rise apartment blocks are proposed, driven pile or raft foundations may be utilised depending on the structural loadings proposed. An ABP in the order of 100 kN/m^2 can be achieved at circa 2.00 m across the site based on existing ground levels. An ABP in the order of 200 kN/m^2 can be achieved from circa 2.50 m bgl. Foundation depths should take account of the presence of existing and proposed trees, with foundations deepened locally to mitigate the potential for volumetric instability attributed to fluctuations in moisture content, in accordance with the requirements of NHBC standards. It is recommended that at the working drawing stage, a foundation schedule is prepared for the development, taking account of the physical change of the natural clay soils and the current/proposed locations of trees.

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 geotechnical foundation zoning plan and structural engineer's drawings should be referenced to determine the proposed foundation solution.
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. • Monitoring of the water quality within the culverts. • Controlled removal of all trees and vegetation and compliant removal of all waste stockpiles. • Removal and treatment of all invasive plant species (as required) in accordance with a specialist contractor method statement, validation and independent certification. • Decommission of all interceptors, tanks and active drainage infrastructure in accordance with the contractor method statement and ensuring no environmental impact. • Management of all anthropogenic material impacted by trace asbestos fibre in a controlled and legislatively compliant manner. • Identification, delineation and removal of organic materials within infilled ponds. • Removal of all structures, relict foundations and buried features in their entirety. • Removal of all materials considered geotechnically deleterious. • Excavation and processing of Made Ground in a controlled manner with the sorting, processing and segregation of identified deleterious materials to 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 the wider environment. • Importation of suitable material (if required) to achieve the required development levels.

	• Replacement of material in accordance with the E3P enabling specification and engineering requirements.

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 600 mm cover system using certified material with appropriate validation within proposed garden areas, comprising 450 mm subsoil (potentially site-won natural drift deposits) overlain by 150 mm topsoil. Geotextile membrane break layer in residential gardens. • Provision of a 300 mm cover system using certified material with appropriate validation within proposed areas of public open space and soft landscaping. • Construction of all dwellings with appropriate vapour resistant membranes for elevated semi-volatile contaminants site-wide basis. • Construction of appropriate potable water supply infrastructure.

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1. INTRODUCTION

1.1. BACKGROUND

E3P has been instructed by Kellen Homes to develop a remediation and enabling works strategy for the proposed residential development at the site known as the former Olympic Freight Terminal at Bennett Street, Manchester.

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 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:

- **WYG** – *Phase II Geo-Environmental Ground Investigation Interpretative Report*. Reference E11056-1, January 2008. Prepared for Braidwater Ltd.
- **E3P** – *Phase I and II Geoenvironmental Site Assessment*. Ref: 15-974-R1-2, dated December 2022, prepared for Kellen Homes.
- **E3P** – *Ground Gas Addendum Report.* Ref: 15-974-R3-1, dated January 2023, prepared for Kellen Homes.

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 reports are summarised in Section 2.

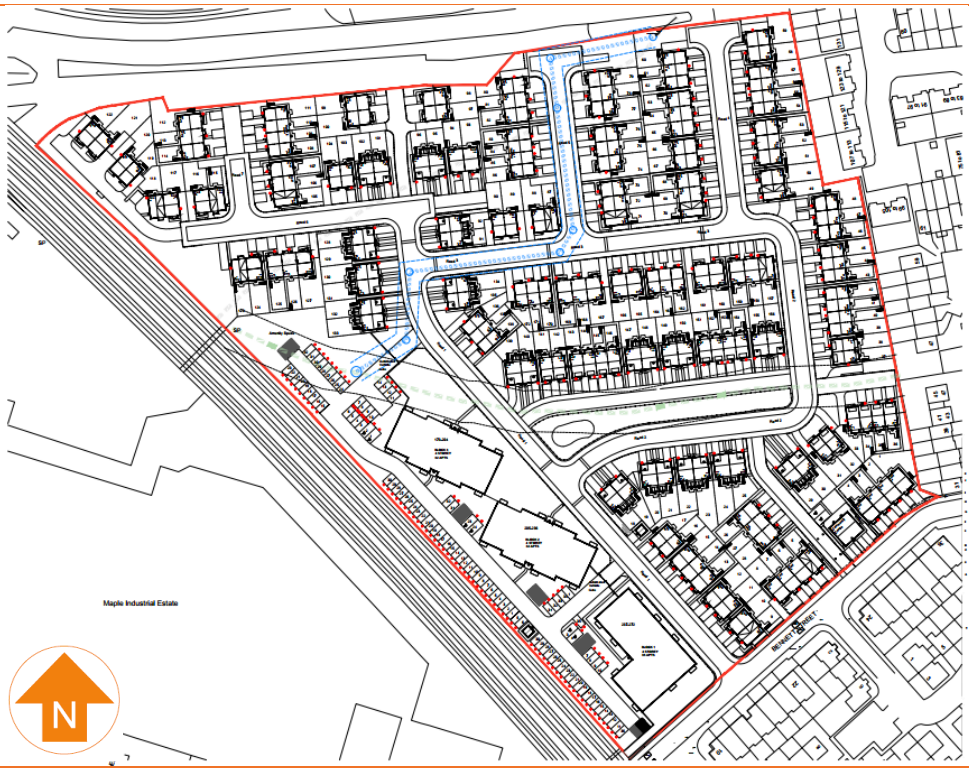
For the avoidance of any doubt, the E3P Geoenvironmental Site Investigation Report should be read both as a precursor to and in conjunction with this document.

1.5. REDEVELOPMENT PLAN

Kellen Homes propose to construct 340 residential dwellings (Class C3) within buildings between two and six storeys in height, and up to 317 sqm of flexible use Commercial Hub floorspace Class E) with two altered access points off Bennett Street; vehicular access from Anthony Close; and associated open space and landscaping.

E3P has been provided with a draft planning layout detailing the proposed layout presented in Figure 1.1.

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	Kellen Homes
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

Kellen Homes are in the process of submitting a detailed planning application to the local planning authority for the proposed redevelopment of the site for low-rise residential housing with associated adopted estate roads and infrastructure.

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	Bennett Street, Manchester, M12 5NL
National Grid Reference	E 386189, N 397031
Site Area	6.08 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 15-425-001.

1.9. SITE SUMMARY

TABLE 1.1 SITE DESCRIPTION AND SETTING

Occupancy/Use	The subject site is a parcel of land located north of Bennett Street, Manchester, and is currently occupied by a container storage depot with associated offices. The majority of the site has shipping containers stacked for storage with various miscellaneous items/waste stored around the site. An above-ground storage tank was also present on-site on a raised platform utilised for refuelling. This was noted to be in poor condition with localised spillages at ground level. A bund was not recorded.

	In the southeast corner, earth mounds are present which are covered in scrub vegetation. There is one disused warehouse in the northeast corner of the site and in the southwest corner, there is a large warehouse. The site walkover took place after heavy rainfall and large standing pools of water were visible in the south of the site over the main road into the site.	
Environmental Setting	**Drift Geology**	Glacial Till - Devensian
	Bedrock Geology	Chester Formation – West – SANDSTONE Manchester Marls Formation – Central – MUDSTONE Collyhurst Sandstone Formation – East - SANDSTONE
	Faults	The Ardwick Fault is located on the western site boundary with a downthrow to the east.
	Hydrogeology	Secondary undifferentiated aquifer in the Drift geology. Principal aquifer in the Chester formation and Collyhurst Sandstone formation, secondary B aquifer in the Manchester Marl.
	Hydrology	Two branches of Corn Brook are recorded underneath the site, these are now fully culverted.
	Flood Risk	The site is in flood risk zone 2 and has a high risk for surface and groundwater flooding in the southwest corner.
	Subsidence Hazard	No hazard identified in data searches.
Site History	A review of the pertinent Ordnance Survey mapping suggests that circa 1848 the site comprised of agricultural land with a building in the centre of the site marked as Burgess Villa. Two branches of Corn Brook run through the site in an east to west direction. By circa 1890, the site was no longer agricultural land, but an iron foundry and boiler works had been developed on-site with associated sidings. Two ponds are marked on-site as well as a travelling crane. The two branches of Corn Brook are no longer marked but have been culverted. The iron foundry had been expanded by circa 1905 and Manchester City football ground was also present in the southern part of the site. The boiler works are no longer marked on the map as well as the two ponds which have been infilled. In circa 1922, the iron foundry is no longer mapped on the site. Buildings were developed and a transport depot has been built circa 1932. The football ground has also been demolished and is no longer mapped. By 1980 the transport depot has been marked as a bus depot, the site layout remains largely unchanged until the present day. **Offsite** Potentially contaminative uses identified in the surrounding area have included: Railways, historical boiler works and general redevelopment of the site and surrounding area may be a source of Made ground.	
Landfill Sites and Ground Gases	No landfill sites (current or historic) are located within 250 m of the site. The site has undergone some historic development and ground working, the Made Ground associated with the historic development and infilling of historic ponds may produce hazardous ground gases such as methane and carbon dioxide.	
Radon	Between 1-3% of houses above the 'Action Level' – no special precautions are required.	

1.10. SUMMARY OF REPORTED GROUND CONDITIONS

E3P has previously prepared a detailed Phase 2 Report and 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 TO 5.45 m bgl** Made Ground deposits have been encountered within all exploratory hole locations to a maximum proven depth of 5.45 m bgl (WS106). Although in general, Made Ground in the south of the site extends to circa 2.00 m bgl and 3.00 m in the north. Beneath the main building in the south-east, Made Ground was proven to a depth of 1.30 m bgl and comprised concrete over yellowish-brown, slightly clayey gravel over reworked gravelly clay. Made Ground could not be proven to its full extent at WS106, WS111, WS112, WS115, WS124, WS128 and WS136. This was due to obstructions in the east of the site, cobbles within Made Ground or dense Made Ground. During the supplementary ground investigation, the full extent of made ground could not be proven within five locations (TP107, TP110, TP123, TP126 and TP128) due to the instability of pits, pit collapse and the influx of groundwater. In general, the majority of locations identified asphalt or concrete surface cover overlaying reworked gravelly clays containing gravel of mixed lithology, including brick, concrete, clinker, ash, ceramic, sandstone and coal. Beneath former structures in the north east and south of the site, concrete was generally underlain by blackish brown gravelly fine to medium sand, with gravels of concrete, mudstone, sandstone, and brick between depths of 0.40 – 2.10 m bgl (TP127). Fragments of metal, ceramic, and timber were also encountered within this material. In one location, the concrete slab was underlain by soft grey clay with plant debris between 0.05 – 1.10 m bgl (TP118). Hydrocarbon odours were identified in 16 of the 36 locations within Made Ground, with no evidence of any specific separate phase impact. Relict foundations will likely be present across the site, beneath former and existing building footprints and railway tracks. A Depth of Made Ground Plan is presented as Drawing 15-974-006 in Appendix III.
Drift	**DRIFT – 0.40 m bgl to 5.45 m bgl** Drift deposits were identified within the majority of exploratory hole locations to a maximum proven depth of 30.50 m bgl (RB202). In general, drift deposits were encountered as a firm to very stiff brown CLAY with varying sand content. Drift geology was generally homogenous across the site. Granular deposits comprising brown gravelly SAND with gravel of sandstone and mudstone were generally found at greater depth (>10.00 m bgl) overlying the bedrock. Pockets of organic deposits were identified at 3.50 m bgl within WS113.

Bedrock	**SOLID – 12.10 M BGL TO 40.00 M BGL** Bedrock was encountered within the advanced rotary boreholes only between 12.10 m bgl (rb104) and 30.50 m bgl (rbh202) to a maximum proven depth of 40.00 m bgl. A red sandstone was identified beneath the drift overlying a reddish grey mudstone with sandstone bands. In general, the bedrock is shallower in the east of the site and deeper in the west.
Groundwater	**GROUNDWATER –** Groundwater was encountered between 0.50m bgl to 1.80m bgl during the site investigation.

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:

- Asbestos - Chrysotile
- Heavy Metals – Arsenic, Lead, Mercury and Zinc.
- PAHs – Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Fluoranthene, Phenanthrene, Pyrene, Benzo(a)Anthracene, Chrysene, Benzo(b)Fluoranthene, Benzo(k)fluoranthene, Benzo(a)Pyrene, Indeno, 1,2,3-cd)pyrene, Dibenzo(a,h)Anthracene and Benzo(ghi)perylene.
- Hydrocarbon fractions - C10-C12, C12-C16, C16-C21 and C21-C35.
- 4-Methylphenol
- 2, 4-dimethylphenol

Volatile organic contaminants (VOCs) above the limit of detection have been identified in WS121 at 0.70 m bgl, WS112 CD1 0.50 m bgl within Made Ground samples.

Semi-volatile organic contaminants (SVOCs) were identified above the limit of detection within Made Ground samples during the E3P investigation. During the previous WYG investigation SVOC were identified above the detection limit at WS112 CD1 (0.50m), BH1 D2 (0.95m), WS122 CD3 (3.90m).

In relation to heavy metals, non-volatile PAHs and TPH C16-35, these contaminants have primary exposure pathways related to dermal contact and ingestion of soils and consumption of homegrown vegetables. The proposed development of the site will include the hard cover and the importation of certified subsoil and topsoil in areas of private gardens and landscaping, thus removing this pathway.

Where mercury exceedances have been identified, WS123B, WS135 and WS136 have been speciated and show the elemental mercury level to be below 1.2 mg/kg of elemental mercury. As such, the mercury exceedances in these areas can be addressed using a clean cover system.

The remaining mercury exceedances (WS115 and WS117) did not have enough sample left to speciate the mercury, and so, have a theoretical vapour risk.

SVOCs above the limit of detection (LOD) have been identified across the site within Made Ground at WS101, WS104, WS110, WS107, WS117, WS115, WS116, WS118, WS128, WS121, WS133, WS135, WS136 and within TP103, TP106, TP107, TP111, TP120, TP122, TP124. The SVOCs identified within both phases of E3P investigation and their maximum recorded value are as follows:

- 4-methylphenol (100 mg/kg)
- 2,4-dimethylphenol (49 mg/kg)
- 2-methylnaphthalene (610 mg/kg)
- Dibenzofuran (870 mg/kg)
- Carbazole (440 mg/kg)
- Anthraquinone (120 mg/kg)

The above compounds have been compared to the available Atkins ATRSK tables where a value is prescribed, and elevated concentrations are still identified at WS121. Dibenzofuran, carbazole, anthraquinone, 2-methyl naphthalene and 2,4-dimethylphenol do not have prescribed GAC values; as such, any presence has been considered a theoretical risk.

E3P has undertaken further risk-based assessment for pertinent compounds is discussed below.

2-Methylnaphthalene

2-methylnaphthalene is a white crystalline **solid** compound.

This determinand is classified as a non-threshold substance, therefore even the smallest amount of exposure is considered to pose a theoretical risk to the critical receptor within the context of the developed CSM.

The vapour pressure of 2-methylnaphthalene (0.055 mm Hg @ 25°C) is slightly lower than that of naphthalene ((0.085 mm Hg @ 25°C), it is therefore determined that the compound is less volatile than naphthalene. This data is obtained from Pub Chem.

The Tier 1 CIEH / LQM S4UL for naphthalene is 2.3mg/kg for a residential with plant update scenario, however this assessment assumes dermal contact, inhalation of particulate and other direct exposure pathways. The developed CSM for the subject site incorporates clean cover systems to ensure no direct exposure pathways.

When considering that 2-Methylnaphthalene has a notably reduced vapour pressure to that of naphthalene, the absence of the compound in the vast majority of samples tested (38 of 45) and in due consideration of the maximum concentration of the determinand being only 1.5 ppm, the potential for this compound to enter the vapour phase from soil with temperatures ~10°C is low.

There is no justifiable or peer reviewed toxicological data for an inhalation pathway for 2-methylnaphthalene, therefore is it not possible to develop a robust site-specific risk assessment model given the absence of suitable input parameters.

In light of the above, we must consider the lines of evidence to hand and given that the compound is a non-threshold substance with no peer reviewed, robust or justifiable toxicological data the suggested method to ensure safe regeneration is the adoption of the As Low As Reasonably Possible (ALARP) approach.

In this instance, the methodology for the analytical technique is considered to be the lowest reasonably possible method of determining the presence of the non threshold substance and mitigating risk to the lowest practicable level.

The US national library for medicine confirms:

If released to soil, 2-methylnaphthalene is expected to have slight to no mobility based upon log Koc values of 3.00-5.96. Volatilization from moist soil surfaces is expected based upon a Henry's Law

constant of 5.18X10-4 atm-cu m/mole. However, adsorption to soil is expected to attenuate volatilization. 2-Methylnaphthalene is not expected to volatilize from dry soil surfaces based upon its vapor pressure.

This compound has a very low to no actual volatility, there is no inhalation of dust (indoor or outdoor air) or inhalation of vapour (indoor or outdoor) exposure. The total inhalation background is 1.52%.

As discussed, herein it is highly unlikely that this compound can enter the vapour phase in the soil temperatures furthermore the presence of a passively ventilated sub-floor void with a reasonable volume change potential (24hr) will ensure that in the extremely unlikely event that this compound could volatilise and migrate, the standard mitigation measure would ensure there is absolutely no potential for ingress into the habitable space.

The US EPA has a residential screening value of 24mg/kg for this compound, while this value cannot be utilised for a SSRT, it must be noted that the risk based approach assumes significant dermal uptake. Therefore within the context of the developed site CSM and the lines of evidence approach, it can be determined that the residual compound in this instance is highly unlikely to pose any risk in terms of vapour migration and ingress to the dwelling.

Dibenzofuran

This is a white solid compound generally derived from coal tar.

There is little or no toxicological data for dibenzofuran, therefore it is not possible to generate a site specific risk based assessment criteria to determine at what concentration the compound would post no unacceptable level of risk when considering a vapour exposure pathway in isolation.

The relatively low volatility of this compound within soils with a temperature of ~10°C all but inhibits any volatilisation potential.

In the absence of any viable peer-reviewed toxicological data, the ALARP principle is adopted, therefore works on-site will ensure removal of this material where possible and incorporation of robust and highly risk adverse mitigation measures in the construction of new dwellings.
The US national library for medicine confirms:

Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 2.1X10-4 atm-cu m/mole. However, adsorption to soil is expected to attenuate volatilization.

Dibenzofuran is not expected to volatilize from dry soil surfaces(SRC) based upon its vapor pressure

The US EPA has a residential screening value of 7.3mg/kg for this compound, while this value cannot be utilised for a SSRT, it must be noted that the risk-based approach assumes significant dermal uptake.

Carbazole

Carbazole is a non-threshold substance.

Carbazole 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 a 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. Volatilization from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 1.16X10-7 atm-cu m/mole. Carbazole is not expected to volatilize from dry soil surfaces based upon its vapor 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 soil or water there cannot be a complete pollutant linkage in this instance.

The recorded concentrations are marginally above the limit of detection for the analytical method.

Anthraquinone

Anthraquinone is a polycyclic aromatic hydrocarbon derived from *anthracene* or *phthalic anhydride*. Anthraquinone is used in the manufacture of dyes, in the textile and pulp industries, and as a bird repellant.

The US national library for medicine confirms:

If released to soil, anthraquinone is expected to have slight to no mobility based upon a Koc values of 2,755-17,416. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 2.35X10-8 atm-cu m/mole. ***Anthraquinone is not expected to volatilize from dry soil surfaces based upon its vapor pressure of 1.16X10-7 mm Hg.***

The US EPA has a residential screening value of 13mg/kg for this compound, while this value cannot be utilised for a SSRT, it must be noted that the risk based approach assumes significant dermal uptake. Therefore within the context of the developed site CSM and the lines of evidence approach, it can be determined that the residual compound in this instance is highly unlikely to pose any risk in terms of vapour migration and ingress to the dwelling.

In relation to SVOCs (including naphthalene), VOCs, unspeciated mercury samples and TPH C10-16, these contaminants have primary exposure pathways related to inhalation of vapour. The majority of the SVOC exceedances are identified in locations with elevated levels of volatile TPH, which is attributed to be the source of the SVOCs. On review of the current site activities, it is considered highly likely that the original cobbles across the site are bounded by coal tar cement. Prior to the supplementary investigation the cobbles had been lifted and removed. This recorded a reduction in TPH exceedances – as anticipated – as the source of TPH, the coal tar, has been removed. However, residual organic pollutants associated with the coal tar remain as highlighted by the presence of site wide SVOCs above the LOD; As such, to mitigate the residual risk from SVOCs across the site a provision for vapour membranes should be made for all proposed plots. This would severe the contamination pathway between source and receptor and mitigate the risk to the end-user against indoor vapour inhalation.

VOCs identified above the LOD in Made Ground at WS115 (0.40m) are attributed to the identified TPH impact in this location. The VOC results have been compared against the Atkins ATRISK values for residential with plant uptake and the chemical results are below the target values presented. As such, no further risk assessment is considered to be required.

Asbestos has been identified within a localised area in shallow Made Ground deposits (WS125 at 0.50 m bgl). Asbestos quantification has shown <0.001 % asbestos therefore, soils should be placed beneath a cover system depth. No visual signs of ACM were encountered during the ground investigation; it is, therefore, likely that only trace fibres are present. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 2.1.

FIGURE 2.1 ASBESTOS RISK MITIGATION CONCEPTUAL SITE MODEL



Notes
ND None Detect
0.001% Soils may contain ≤ 0.001% asbestos using composite testing to ensure there is no potential risk to human health. This value is present within areas where there may be a short term low-level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (dust suppression)
0.1% Soils at a depth of >1.00m bgl may contain <0.1% asbestos using composite testing where they will not be likely to be disturbed in the future and will therefore be in an area of low sensitivity. Risk assessment completed in accordance with Asbestos JIWG risk assessment tools.
Undefined- this will be dependent upon soils encountered during earthworks, which may be placed at these depths to ensure no potential risk to human health.

Chemical analysis of the natural clay drift deposits has identified these soils to be acceptable for use as subsoil within the proposed garden areas; however, further chemical validation samples will be required to confirm this. There are no suitable sources of topsoil available on the site.

All proposed garden and landscaped areas within the development are to be installed with a 600 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 residential end-use subject to the completion of the supplementary assessments and the following build-phase mitigation items:

- Management of soils to ensure that all materials impacted by asbestos fibres are placed in areas of low sensitivity during the site enabling works.
- Use of potable water supply infrastructure that will be compliant with United Kingdom Water Infrastructure Risk (UKWIR) assessment criteria.

- Construction of all dwellings with vapour membranes.
- Construction of a 600 mm clean cover system for all areas of the private garden 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 Geoenvironmental Site Assessment, the findings of which are summarised as follows:

- There have been multiple phases of ground investigation, which has enabled reasonable characterisation of the pollution risk and potential to impact the critical receptors;
- Low permeability cohesive clay deposits encountered site wide beneath the site will inhibit the downward migration of contamination and offer protection to the underlying aquifers.
- Site wide heavy metal, PAH and isolated TPH exceedances have been recorded within leachate analysis and perched groundwater. This is considered to be associated with residual impact to shallow anthropogenic materials. All primary and secondary pollution sources have now been removed from the site in their entirety.
- Within Black Brook, minor heavy metal (copper and zinc) and PAH (anthracene and fluoranthene) exceedances have been identified in comparison to EQS. However, significant exceedances of naphthalene and TPH (C10-C16) exceedances have been identified in comparison to the EQS. This indicates a minor heavy metal and PAH impact is present within the surface water feature, with a more significant TPH and naphthalene impact likely associated the current and historic industrial activities in the area. Further surface water testing should be undertaken up and down stream of the site to confirm this.
- Within Corn Brook – identified as the primary receptor – minor exceedances of heavy metal (zinc and total cyanide) and PAH (naphthalene) exceedances have been identified in comparison the EQS. This indicates a minor heavy metal and PAH impact is present within the surface water feature, likely associated with the wider industrial activities in the area. Further surface water testing should be undertaken up and down stream of the site to confirm this.
- No exceedances of principal aquifer groundwater samples against DWS;
- Relatively low-level exceedances of heavy metals and PAH were identified within BH202 and BH204 compared to EQS. Given the of active groundwater abstraction recorded within 1km of the site, low permeability of the overlying drift limiting vertical migration and low solubilities and concentrations of heavy metal and PAH recorded, there is considered to be no unacceptable risk to the underlying aquifer.
- Black Brook is to be diverted as part of the proposed development and will be fully encapsulated; as such, it is not considered that Black Brook will be in hydraulic continuity with the site upon completion of these works.
- Corn Brook is to remain untouched; at this stage, it is assumed that it is in hydraulic continuity with limited perched waters beneath the site. As such, Corn Brook has been identified to be the critical receptor for controlled waters.

- A full survey for Corn Brook is not currently available. However, it is likely that the culvert is sealed off from the site as such not in hydraulic conductivity. A survey should be completed to confirm the condition of the Corn Brook culvert, with repairs made in areas of degradation and damage. Upon completion of this works it is considered that there will not be a direct contamination pathway between the site and surface water features, as such, no unacceptable risk the controlled water receptor will be present.

- Further analysis of the surface water in Black Brook and Corn Brook should be undertaken as groundworks progress to ensure no future mobilisation of contaminants is caused, which may pose a risk to the watercourse

2.4. GROUND GAS

Ground gas has been assessed by E3P as part of the E3P Geoenvironmental Site Assessment. The assessment was completed in accordance with the methodology outlined in the CIRIA publication C665, 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

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS101	11/01/2022	1.34	Flooded						
	04/02/2022	2.25	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	2.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	2.53	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	2.60	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	2.51	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	2.61	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	2.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	2.87	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS103	11/01/2022	1.13	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.20	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	1.04	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	1.25	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	1.07	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	1.23	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	1.40	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	1.52	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS104	11/01/2022	-	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	-	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	-	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS107	11/01/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.9	0.1	0.1	0.0001	0.1	0.0001	CS1	Green

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
	22/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS109	11/01/2022	1.77	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	2.00	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	2.20	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	2.34	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	2.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS110	11/01/2022	1.64	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.85	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS113	11/01/2022	1.42	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.43	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	1.55	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	1.30	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	1.69	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	1.71	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	1.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	1.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS114	11/01/2022	0.61	Flooded						
	04/02/2022	1.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.15	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	1.04	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	1.55	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	1.03	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	1.05	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	1.09	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	1.20	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS116	11/01/2022	1.70	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.90	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS119	11/01/2022	1.38	Flooded						
	04/02/2022	2.30	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS120	11/01/2022	1.82	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS122	11/01/2022	0.83	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.00	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS126	11/01/2022	3.05	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	3.40	0.1	0.1	0.0001	0.1	0.0001	CS1	Green

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
	08/03/2022	2.99	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	3.11	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	2.85	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	3.27	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	3.27	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	3.32	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	3.32	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS127	11/01/2022	1.05	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	1.25	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS129	11/01/2022	1.26	Flooded						
	04/02/2022	2.10	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS130	11/01/2022	1.68	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.85	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS131	11/01/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS132	11/01/2022	0.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	0.90	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	0.88	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	0.92	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	0.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	0.96	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	0.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	0.84	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	0.94	0.1	0.1	0.0001	0.1	0.0001	CS1	Green

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH_4 (%V/V)	MAX CH_4 Q_{hg} (l/hr)	MAX CO_2 (%V/V)	MAX CO_2 Q_{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS135	11/01/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	04/02/2022	1.00	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	08/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/03/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	05/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	25/04/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	16/05/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	10/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/06/2022	Dry	0.1	0.1	0.0001	0.1	0.0001	CS1	Green

E3P have assessed the previous variables and come to the following conclusions:

- Ground gas monitoring suggests that the site could be classified as CS1/Green, and it is considered that gas protection measures would not be required if the site was considered within the context of the potential risk from CO2 and CH4.
- Made Ground deposits were identified within each exploratory hole location advanced on the site to a maximum proven depth of 5.45 m bgl (WS106). Although in general, Made Ground in the south of the site extends to circa 2.00 m bgl and 3.00 m in the north.
- Drift deposits were identified as brown stiff to very stiff CLAY.
- Monitoring wells set within Made Ground deposits did not record any elevated readings of CH4 and CO2.
- Organic deposits in WS113 did not produce any elevated readings.
- The Site Conceptual Site Model (CSM) identified a site-wide risk associated with volatile and semi-volatile aromatic (polycyclic) hydrocarbons related to coal tar residues used as a sealing material to sandstone cobble sets. Removing / remediation of the residual PAH impact within the near-surface anthropogenic materials is not practicable or sustainable. The developed site CSM, therefore, requires that mitigation measures, including a vapour resistant (aromatic hydrocarbons), be installed within all new dwellings.
- All dwellings will be constructed and installed with mitigation measures that will inhibit the ingress of vapours in accordance with CIRIA 748.
- While the site is classified as CS1, the requirement for vapour mitigation measures will be virtue of their design and installation requirements also ensure all dwellings have ground gas mitigation protection that would be compliant with a minimum CS2.
- It is recommended that the full ground gas assessment and recommended protection measures (if applicable) are agreed upon with the local authority before their adoption on-site. Furthermore, a suitably qualified engineer should validate all protection measures adopted.

2.5. 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 and it will be necessary to delineate the impacted soils where present at locations that could potentially impact the potable water infrastructure should be suitable to remediation with robust validation testing.

If unacceptable concentrations remain 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 principles as set out within the Environment Agency publication Land Contamination: Risk Management (LC:RM)(updated May 2020).

The LC:RM requires that the following tired assessments are followed to ensure a 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 options.

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.

The multiple phases of intrusive ground investigation works completed to date are considered suitable in order to fully understand the risks to future end-users, controlled waters and the wider environment.

As such, in this instance, it is considered that there is sufficient information to inform the detailed site characterisation which has determined that the primary pollution risk is associated with the presence of impacted made ground across the site.

Extensive near-surface ground investigations have been completed within the areas of significant pollution risk with further deep investigation within the bedrock aquifer.

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;
- Noise restrictions;
- Baseline ambient air quality; and,
- Weather conditions.

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 a 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 IV of this report.

Noise Restrictions

The contractors environmental plan of works will include boundary noise monitoring stations to assess the noise impact, daily monitoring and mitigation measures to ensure no unacceptable degree of impact to the identified receptors. Given that noise impact can be controlled, this is not considered a limiting factor in the selection of the correct remediation option.

Weather Conditions

Given the size and scale and variable remediation works required, it will be possible to ensure that the programme allows for a differentiation in operations to ensure works can proceed in areas depending on the prevailing weather for a specific period of time.

3.4. CONTAMINANTS OF CONCERN (COC)

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

The human health risk drivers for the heavy end TPH fractions, non-volatile PAHs and heavy metal 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.

3.4.2. ASBESTOS

Asbestos fibres were identified within WS125 (0.50 m bgl). Asbestos quantification has shown <0.001 % asbestos therefore, soils should be placed beneath a cover system depth. No visual signs of ACM were encountered during the ground investigation; it is, therefore, likely that only trace fibres are present. This material will require careful management and subsequent placement in an area of no future sensitivity in accordance with the E3P Developed Conceptual Site Model (CSM).

It should be assumed that asbestos fibres are present throughout the Made Ground on site. The risk to chronic human health associated with the elevated concentrations of loose chrysotile and fibres (<0.001%) can be mitigated through the installation of a suitable cover system in all proposed landscaping and hardstanding to remove any potential for direct exposure to impacted soils.

Where asbestos is identified at concentrations above <0.001%, a hotspot excavation will be required and the impacted Made Ground will require placement >1.00 m beneath an area of low sensitivity such as public open space in accordance with the E3P conceptual site model (Figure 2.1).

All 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.

Soils will be placed in areas of no unacceptable future risk in accordance with the E3P validation method.

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 residential dwellings, 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.

3.4.3. SEMI-VOLATILE TPH, PAH, SVOC

Semi-volatile TPHs, naphthalene and SVOCs have been identified across the site in shallow Made Ground which presents potential volatilisation to indoor air risk.

The source is attributed to coal tar used to seal between the cobbles, all such material has been removed as part of the site demolition, therefore the source of hazardous waste is largely remediated.

Prior to the supplementary investigation, the cobbles had been lifted and removed. This recorded a reduction in TPH exceedances – as anticipated – as the source of TPH, the coal tar, has been removed.

To mitigate the residual risk from SVOCs across the site, a provision for vapour membranes should be made for all proposed plots. This would remove the contamination pathway between source and receptor and mitigate the risk to the end-user against indoor vapour inhalation.

In due consideration of the potential for SVOC impact to represent a vapour intrusion risk, it is considered that vapour resistant membranes will be required within all proposed dwellings.

3.4.4. MERCURY

In addition to the above, elevated concentrations of mercury that have not been speciated pose a theoretical vapour risk. To address the impact of residual SVOCs across the site it is considered that vapour resistant membranes will be required within all proposed dwellings, this in turn will mitigate the risk to end users from the potential vapour risk associated with elemental mercury.

A cover system within all private gardens and soft standing will be suitable to mitigate the risk associated with the mercury that has not been identified as elemental.

3.5. IDENTIFICATION OF FEASIBLE REMEDIATION OPTIONS

3.5.1. 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 ensures no risk to an identified receptor during the works in terms of odour, air quality or noise impact.

3.6. 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 of the site:

- Construction of low permeability **capping system** (cover system) to limit infiltration of precipitation to reduce the mobility of soluble phase impact and ensure no direct exposure pathway to future receptors.
- Construction of dwellings with **specialist membranes** and mitigation measures to ensure no ingress of volatile phase hazardous compounds into a dwelling; 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.

3.7. 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 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. If any residual coal tar (associated with sealing cobble sets) is identified, this material will be delineated under the supervision prior to removal to a hazardous waste facility.

RE-2 – ENVIRONMENT AND NUISANCE CONTROL

Management of all works is required so as 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 upon with the local authority and implemented on-site.

RE-3 – Risk to Infrastructure and Culverts

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

All works to be completed within the main river channel (culvert) will require the appropriate EA permit, this should be obtained prior to the commencement of any activities (including demolition). It should be noted that works to the main river channel may be restricted during certain times of the year.

Monthly sampling of the underground culverts at upstream and downstream points should be undertaken to ensure no detrimental effect to the surface waters is taking place during enabling works.

RE-4 – Identification, Isolation and Treatment of Invasive Plants

Invasive plant species have not been identified on-site to date. The remediation contractor must satisfy themselves with respect to the extent of all species deemed invasive, if any, prior to the commencement of works on site. The contractor shall employ a suitably qualified expert to investigate the presence of invasive plant species on or adjacent to the site. Once all invasive plant species are identified, these will be treated in strict accordance with an approved method statement to be submitted to the supervising consultant for review prior to the instigation of any works.

Where invasive plant species are identified at the site boundary, a suitable barrier shall be installed to prevent any future reinfestation of the subject site.

Upon completion of the eradication of all invasive species, a validation report should be prepared documenting all identified invasive plant species, their location and the treatment methodology. Where materials are removed from site, all waste transfer notes/duty of care certificates should be included within the validation statement.

RE-5 – Site Clearance Operations

Post-demolition general site clearance and provision of welfare, offices and site security are to be determined as per the contract requirements.

The site is currently overgrown in some areas with self-seeded vegetation with extensive above- and below-ground structures; this material should be removed in a controlled manner with full compliance with any ecological mitigation measures that are required for the works. Any such measures are outside the scope of this report.

All vegetation should either be stockpiled at a pre-agreed location or alternatively removed from the site in accordance with waste permitting regulations.

All root networks are to be removed in accordance with the requirements of the NHBC/LABC.

Significant stockpiles of waste, including construction, demolition and domestic waste have been identified at the site. These should all be removed in line with legislation to ensure no hazardous wastes remain on site prior to any excavation works.

RE-6 – Delineation, Excavation and Treatment of Identified Asbestos Impact

Detectable asbestos fibres have been identified in discreet locations (WS125 at 0.50 m bgl); however, due to the nature and age of the filled material, it must be assumed that trace fibres are present throughout the Made Ground. The E3P Developed Conceptual Site Model demonstrates a suitable method for the management of soils to negate any future risk.

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

Where any visual evidence of ACM is identified, these materials should be carefully segregated and removed from the soil matrices (if/where possible).

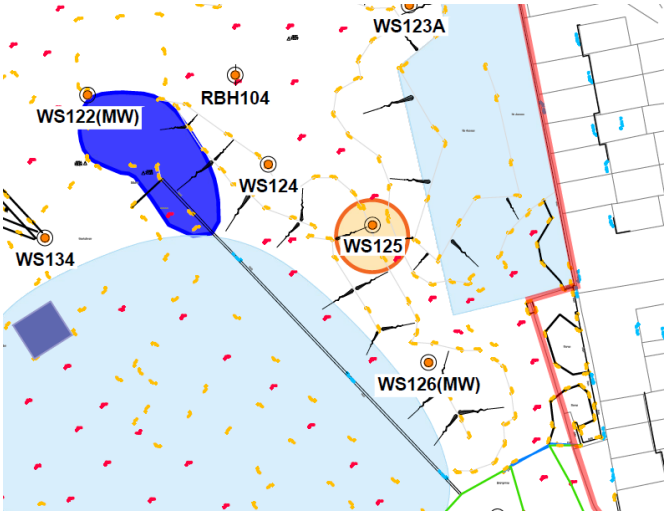
Validation sampling of the processed Made Ground should be completed to demonstrate compliance with the developed conceptual site model.

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.

If necessary, reassurance air testing in accordance with the requirements of HSG248 should be completed during the operation to move the soils to demonstrate the deployment of the required control procedures and safe working methods.

The location of known asbestos impacted soil is shown in Figure 3.2

FIGURE 3.2 LOCATION OF IDENTIFIED ASBESTOS IMPACT



RE-7 – Delineation, Excavation, Treatment and Disposal of Visual and Olfactory Semi-volatile Impacted Material – TPH, Naphthalene, SVOC

Semi-volatile contamination has been identified within the Made Ground across the site, this is attributed to a residue from the coal tar sealant used within the former cobble sets across the site. The cobble sets and coal tar sealant has been removed during the site demolition works.

It is considered that this material represents an unacceptable risk associated with volatilisation to indoor air, migration towards controlled waters receptor and odour nuisance that cannot be mitigated through the construction of a clean cover system.

The proposed remediation works will include the full depth turnover of all Made Ground under the part time supervision of an independent geoenvironmental consultant from E3P. During this, frequent monitoring utilising a PID should be undertaken with turnover soils chemically validated in line with section 3.8 of this report.

The impact of semi-volatile contamination is site wide and so hotspot removals will not be undertaken unless a point source is identified. As such, at build phase, a provision for vapour resistant membranes should be given for all dwellings.

In the event any residual visible coal tar impact is identified, this will be delineated and removed from site to a hazardous waste facility.

In the likely 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 soil leaching and dispersal of any odours and/or vapours. This material will then be subject to detailed laboratory analysis to determine the level of semi-volatile contamination present and establish whether it is suitable for reuse or requires off-site disposal.

The results of this assessment will establish the extent to which vapour resistant membranes will be required 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 remains.

The location of known semi-volatile impacted soils (naphthalene, TPH, SVOC) are shown in Figure 3.3 (red, orange and blue circles) and on the Human Health Exceedances Plan (Drawing 15-425-019) in Appendix III.

FIGURE 3.3 LOCATION OF IDENTIFIED HYDROCARBON IMPACT



RE-8 – Excavation, Breaking and Processing of All Above- and Below-Ground Structures

Obstructions, relict foundations and infrastructure (apart from live services) are to be removed from the areas of proposed residential development, to include plot footprints, rear gardens, private driveways, adopted highway and utilities infrastructure (road box) 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.

RE-9 – Delineation, Excavation and Treatment of Infilled Historical Ponds

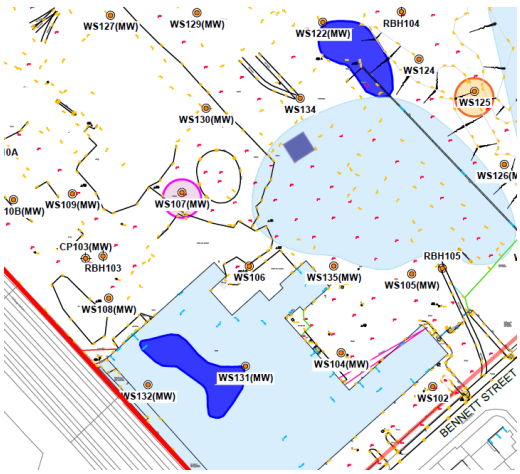
Prior to the commencement of the main earthworks (where possible), all known former infilled ponds should be clearly identified and demarked and investigated to assess the nature of materials and the extent of any deleterious elements.

The location of known historic infilled ponds are identified in dark blue within the E3P Historical Features Plan and Remediation Issues Plan (Drawing 15-425-019) in Appendix III and in Figure 3.4.

All materials that are deemed to be organic – and thus exhibiting unsatisfactory geotechnical properties – must be removed, with the resulting excavation to be backfilled with materials deemed compliant with the E3P Geotechnical Performance Specification with appropriate compaction for the intended land use.

A suitably qualified geotechnical engineer will need to monitor the works and confirm when all unsuitable material has been excavated and removed from beneath any proposed structure or infrastructure.

FIGURE 3.4 LOCATION OF IDENTIFIED PONDS



RE-10 – Removal of Deleterious Material

The E3P Ground Investigation identified potentially deleterious wastes across the site. All potentially deleterious materials will be delineated, stockpiled and removed from the site by the contractor to a licensed waste facility. Prior to the commencement of the main works, the contractor, under the supervision of E3P, will undertake to complete further confirmatory ground investigations to satisfy themselves with regards to the extent of any buried anthropogenic deleterious materials that are unsuitable for retention within a low-rise residential development.

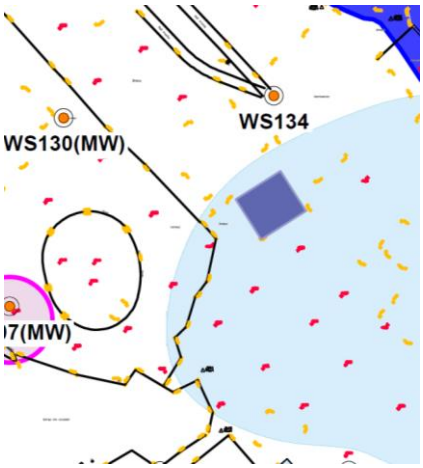
RE-11 – Removal of ASTs

All redundant above-ground storage tanks (ASTs) will require emptying, decommissioning and removal from the site. Should the tanks contain any residual liquids, this should then be uplifted by the vacuum tanker or a surface-mounted pump (peristaltic or double-diaphragm).

The underlying concrete slab will then be broken out revealing the underlying soils. Any soils with visual or olfactory evidence of hydrocarbon impact will be excavated, delineated and placed on impermeable MDPE for subsequent chemical validation. Validation analysis will be undertaken in line with Table 3.2, with the results compared with the remedial target values for the protection of human health and controlled waters. Any soils that exceed these site-specific screening values will be disposed of off-site in accordance with UK waste management legislation.

The location of the AST is shown in Figure 3.6 in dark blue.

FIGURE 3.6 LOCATION OF AST



RE-12 – Investigation and Removal of USTs

Given the historical development at the site, there is considered the potential for previously unidentified underground tanks to be present. During the remediation and enabling works, any tanks identified will have to be investigated as the contents of any such tanks are unknown and no evidence is present to suggest decommissioning.

It is proposed to break out all hardstanding around the tanks and inspect their integrity if identified. If the tank is found to be intact, hydraulic shears should be utilised to open the tank along the top and peel back the steel, thus rendering the tank an open vessel and no longer a tank form. The tanks should be checked for vapours using a lower explosive limit (LEL) meter. If they are deemed to be free of vapours, a 24-hour certificate will be issued, during which time the tanks should be rendered unusable (by cold cutting). Should the tanks contain any residual liquids, this should then be uplifted by the vacuum tanker or a surface-mounted pump (peristaltic or double-diaphragm).

Any tank backfill material will be broken up and removed from the tank structure by the excavator until the tank is sufficiently light to be lifted and emptied. All oversize materials will be stockpiled and checked for hydrocarbon impact pending chemical validation analysis. It is likely the material present inside the tanks will require disposal off-site, in accordance with UK waste management legislation.

The sides and bases of excavations will need to be chemically validated to ensure that soils are below the site-specific remedial validation criteria for the protection of human health and controlled waters. All waste transfer certificates will be required to be retained and included within the remediation validation report.

RE-13 – Cut-And-Filling of Made Ground to Development Levels

The Made Ground is noted to be present to substantial depth in some areas of the site (> 2 m). It is considered that it will be possible to utilise vibro stone columns (VSC) within areas of segregated and placed granular Made Ground to treat the currently unknown potential for differential settlement and ensure a uniform safe allowable bearing pressure (ABP) in the order of 125 kN/m^2.

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 before 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 prior to the commencement of filling and compaction works. In-situ density testing is required to demonstrate compliance with the E3P Geotechnical Performance Specification.

RE-14 – Placement and Compaction of Upfill Material to Facilitate Ground Improvement by VSC

Where plots are to be prepared in a manner that will facilitate ground improvement by vibro-stone column, materials must be either compliant with the specified grading requirements for a nominally placed and tracked granular aggregate, or alternatively, they should be engineered to a defined geotechnical standard.

Materials compliant with VSC grading for granular backfill: granular matrix are to be graded with all particles < 125 mm with no more than 10% fines (0.63 micron).

Non-compliant material requiring engineering to geotechnical design: material is to be placed and engineered in accordance with the correct method for the Series 600 classification (1, 2 or 6) with moisture contents to be controlled within acceptable design limits. In-situ density to be confirmed to be > 95% of the laboratory determined maximum (4.5 kg) with < 5% air void ratio.

RE-15 – Construction of Temporary Working Platform

Where plots are to be prepared in a manner that will facilitate ground improvement by vibro-stone column, a temporary working platform will be constructed.

The specific design for such a platform should be obtained from E3P; however, as a minimum this will comprise:

- Proof rolling of the subgrade to ensure a California bearing ratio (CBR) > 3%; and
- Placement of 300 mm of certified 6F2 to be rolled and compacted to ensure a CBR > 6%.

RE-16 – 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 3.1.

Unless specific instruction is issued from the client, plots should be prepared for a strip foundation where the target founding stratum is identified to be present at a depth of 1.5 m below finished floor level (FFL). Consideration is to be given to the need to construct a strip foundation ~200–400 mm into the natural stratum and the contractor remediation elevations.

TABLE 3.1 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-17 – Preparation of Ground for Vibro-Stone Columns Within Tree Influence

Where trees are present, or within their total zone of influence, the contractor must ensure that all cohesive soils are removed to the required depth with the subsequent replacement with a granular blanket to fully mitigate the potential for volumetric instability in the clay soils.

The zone of tree influence will be indicated within the foundation zoning plan and all resultant excavations and subsequent backfilling must be inspected and approved by E3P.

The depth of the granular blanket required will be determined prior to the commencement of the works and in full agreement of the client, but will nominally be equal to or in excess of 2.5 × foundation width.

RE-18 – 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-19 – Preparation of Garden for Cover System

As part of the land remediation works, garden 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 garden, the area will be subject to a reduced-level dig to remove unsuitable material to a minimum depth of 600 mm below finished garden level or verified natural stratum (whichever is the shallower).

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 garden areas where a cover system is required will be subject to plot-specific independent validation.

RE-20 – Provision of Subsoil

The shallow natural drift deposits (predominantly granular soils) are deemed suitable for use within the upper 600 mm of clean cover to residential gardens and areas of soft landscaping. It is therefore deemed viable to reuse 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.

The garden and landscaped areas will require depth validation to satisfy the requirement of the Council of Mortgage Lenders (CML) in order to demonstrate that the appropriate thickness has been provided as a growing medium.

RE-21 – 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 garden and 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-22 – 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-23 – 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 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-24 – 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 pipe-work.

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 9.3. Failure to meet the required specification may necessitate further remedial works.

RE-25 – 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.

3.8. 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 the 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 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 3.2.

TABLE 3.2 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 2500 m^3	F
Site-Won MADE GROUND General Backfill	1 Sample per 5000 m^3	A/B/C/D
Site-Won MADE GROUND General Backfill	1 Sample per 5000 m^3	G
Site-Won Natural Backfill	1 Sample per 5000 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 2500 m^3	A/B/C/D
Subsoil Greenfield Source (450 mm Garden Cover)	1 Sample per 200 m^3	A/B/C/D
Subsoil Brownfield Source (450 mm Garden Cover)	1 Sample per 50 m^3	A/B/C/D
Topsoil Greenfield Source (150 mm Garden Cover)	1 Sample per 200 m^3	A/B/C/D
Topsoil Brownfield Source (150 mm Garden 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
General Engineering Fill (Class 1 and 2 Soil)	1 Sample per 2000 m^3	G

Notes
Suites of Analysis:

A. Speciated PAH.
B. Speciated TPH (C5-C35).
C. Asbestos (ID).
D. CLEA Inorganic Heavy Metals.
E. Asbestos, naphthalene, mercury, speciated mercury, SVOCs and VOCs (dependent on hotspot exceedance)
F. On-Site Screening for VOC Using Calibrated PID.

G. Leachate Analysis of Inorganic Heavy Metals, TPH, Sulphate and PAH.

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

3.9. 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 of 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 the 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 the reuse of materials on the site.

The importation of material for use within the proposed construction of a development platform will be subject to 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 site will have 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

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 appointed contractor will ensure that all geotechnical engineering, earthworks and validation testing will be completed in accordance with the performance criteria as outlined below.

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 ground improvement by Vibro-stone column for all structures.
- Preparation of plots to be suitable for construction with driven pile foundation were proposed high rise buildings are located or in areas where plots overly underlying service infrastructure or adjacent to sensitive network rail land.
- Preparation of plots within influence of culvert (retained) for piled foundations.
- Engineer all areas of the proposed, adopted road and private drive to be compliant with the E3P Geotechnical Specification and in strict accordance with MCHW Series 600.

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 (± 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 majority of the soils won from the processing of demolition material will be granular and cohesive soil matrices.

Due to climatic weather conditions and variance in long-term differential settlement associated with even well-compacted granular soils, and the need to facilitate future re-engineering using vibro-replacement stone columns to support a shallow reinforced strip foundation, 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 in-situ densities that are in excess of 95% of the maximum dry density, as determined using a 4.5 kg laboratory Proctor test.

Materials should only be compacted when the actual moisture content is within 2% (±) 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
Traditional Spread Foundation	Ensure no disturbance of natural soil at shallow depth.
Raft Foundation	Materials need to be placed to ensure 95% compaction and to ensure a minimum CBR of 5% on subgrade.
Re-Engineering of Soils Using Vibro-Replacement Stone Column (VRSC)	Materials to be placed in a controlled manner to facilitate the construction of vibro-replacement stone columns (VRSC) to limit differential settlement and increase net Allowable Bearing Pressure (ABP) **These works are to be completed within the building structure footprint and +2 m of all elevations.** Material must be 90% granular in composition with less than 10% fines (which are classified as materials < 0.6 microns in size). No material greater than 125 mm in size is permitted, with 90% of the soils placed conforming to grading < 90 mm. Material is to be placed when the actual moisture content is within tolerable limits of the optimum, with specific attention to soils that are notably wetter than the optimum. Material to be placed in a manner so as to ensure a minimum CBR of 5% at formation to facilitate machine movement and piling mat construction. Where site-won materials are used to upfill, levels must be compacted to an “end product” performance specification where the in-situ density exceeds 95% of the maximum (determined by laboratory conditions).

LAND USE REQUIREMENT	COMPACTION METHODOLOGY AND GENERAL PERFORMANCE CRITERIA
	Where rock is present at a shallow depth, the remediation contractor will ensure the substratum is prepared to ensure that a minimum of 1000 mm of appropriately graded granular material is present to the underside of the proposed doubly reinforced concrete strip foundation. The substratum must be prepared to ensure a vibro-stone column treatment depth is not less than 80% of the immediate adjacent profile.
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)	*Method Compaction – MCHW Specification For Highway Works Series 600* 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	*Method Compaction – MCHW Specification For Highway Works Series 600* 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 *MCHW Specification For Highway Works Series 600.*

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 is operating 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 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

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

6.6. SPECIFICATION FOR GROUND IMPROVEMENT BY VIBRO-STONE COLUMN

The over-arching method and specification for the placement and compaction of non-compliant material where the fine constituent (< 0.63 micron) exceeds the standard requirements for ground improvement by VSC is given in Table 6.4 & 6.5.

TABLE 6.4 OVERVIEW OF WORKS OPERATIONS

Step 1	Carefully segregate materials excavated during civil engineering works (on site and import) into the following soil types: • Sand/granular soils; • Dry sandy clay; • Wet clay soil; and • Silt. Ensure all stockpiles are sealed to minimise water ingress in approved locations.
Step 2	Analyse bulk sample from each (site-won or imported) soil matrix as per the requirements of the E3P specification for: • Dry density/optimum moisture content (Procter); and • Particle size grading coefficient.
Step 3	On-site observations in conjunction with particle size distribution (PSD) grading will confirm the classification of material and thus the corresponding method for compaction.
Step 4	The dry density/moisture content testing should be used to ensure that the material is within ± 3% of the optimum to ensure compaction can be achieved.
Step 5	The classified material should be placed and compacted in accordance with the corresponding method for the material under conditions where the moisture content is within the tolerable limits.
Step 6	Once placed and compacted, the required validation testing should be completed at formation to demonstrate compliance. The testing will include: • In-situ density and air void ratio; • Moisture condition value; and • Undrained shear strength.

TABLE 6.5 COMPACTION AND VALIDATION OF NON-STANDARD MATERIAL BACKFILL TO VSC

REQUIRED PARAMETERS	**THE COMPACTION MUST ACHIEVE THE FOLLOWING MATERIAL PARAMETERS:**	
Verification Testing and Report	**Bulk Density (ρ)**	95% of the maximum dry density and must be within 3% of the optimum moisture content.
	All materials used for upfilling must be durable and inert.	
	In order to verify that the aforementioned material parameters have been attained, representative sampling and testing must be undertaken. All testing will be in accordance with BS EN ISO 17892-1:2014 and BS EN ISO 17892-2:2014. All testing is to be undertaken by a laboratory with the relevant UKAS accreditation. The following tests are required:	
	In-situ Density (ρ)	Approved methods of in-situ testing (i.e. calibrated nuclear density probe (NDP), sand replacement test).
	Moisture Content	Moisture content test.
	In-situ density testing on every 500 m^3 and in each layer of upfill well-spread over site within and around the proposed structures' footprint. Testing must be from a range of depths throughout the treated fill. A minimum of six samples must be taken and tested. A drawing depicting the location of each sample and test point must be provided along with a list of each point and the relevant test/sample depth. A list of all geotechnical testing results for each sample and test must be provided along with the relevant test certificates. If the soils are not suitable, due to the moisture content being higher than the optimum moisture content, then lime modification may also be required. The above is given strictly on the basis that it does not conflict with other elements of the project-specific requirements.	

6.7. CURRENT AND PROPOSED SITE TOPOGRAPHY AND SLOPE INTERACTION

The current and proposed site topography, changes in elevation and any existing or new slopes are beyond the scope of this specification. Where any earth slopes exceed a design gradient of 1(v) in 3(h) either on site or within the conjectured zone of structural influence, extreme care should be taken with a full and detailed geotechnical slope analysis to inform the retained design solution.



7. RECORD-KEEPING AND VERIFICATION

7.1. RECORD-KEEPING

During the course of the remediation and site enabling works, the on-site E3P consultant 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 E3P on-site engineer during 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 & 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 and validation of sub-soil (clean material) in a 450 mm layer within any plots where the material was not placed during the Remediation & Enabling works;
- Placement and chemical validation of imported topsoil within all gardens; and,
- Installation and validation of vapour protection measures.

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, with respect to human health of the future site users includes the provision of a chemically suitable clean material to be installed in all garden and landscaped areas; the construction of the clean cover / placement of clean material shall consist of:

- 450 mm subsoil
- 150 mm topsoil
- Geotextile break layer in residential gardens

In accordance with 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 environ.

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.

Initial testing of site won sub-soil to classify its re-use on site has been completed as part of the remediation works undertaken. Therefore, further analysis of sub-soil will be required to achieve the testing frequencies outlined within the remediation strategy and in the event of importation of additional material during construction.

Testing requirements for top-soil and sub-soil are presented in Table 9.1.

TABLE 9.1 SPECIFICATION FOR SOIL TESTING

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Subsoil Greenfield Source (450 mm Garden Cover)`	1 Sample per 200 m^3	A/B/C/D
Subsoil Brownfield Source (450 mm Garden Cover)	1 Sample per 50 m^3	A/B/C/D
Topsoil Greenfield Source (150 mm Garden Cover)	1 Sample per 200 m^3	A/B/C/D
Topsoil Brownfield Source (150 mm Garden 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

Garden and landscaped areas need to be backfilled with geotextile breaklayer, 450mm chemically validated subsoil, with 150mm topsoil overlaying this. Topsoil is required to be confirmed as chemically suitable prior to placement. Where sub-soil is not placed during Remediation & Enabling works, E3P will be required to return to site and undertake independent validation of the correct placement of sub-soil.

The placement of 600mm of clean material will be undertaken during the build phase works of the project.

The placement of subsoil and corresponding validation will be documented within the Garden 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.

If natural drift deposits are encountered, excavation can cease here.

E3P will collect photographic evidence of the placement of 150 mm of certified topsoil and 450 mm of subsoil upon completion of construction works. This element will also be checked by the Building Control Officer as part of the site completion prior to issuing of a CML certificate.

The garden validation procedure is detailed in Table 9.2.

TABLE 9.2 GARDEN VALIDATION PROCEDURE

PROCEDURE	METHOD
Chemical Validation	Imported sub-soils 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 subsoils 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 plots given that the 600mm cover system will need to be placed on each plot during the build phase.
Validation	Photographic evidence will be taken by E3P of the topsoil placement demonstrating the depth of topsoil and practical completion of works are required for each plot. For plots where sub-soil depths require validation by E3P during the build phase, photographs will be taken and collated by E3P.
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 garden plots along with the chemical analysis.
Completion Report	Upon completion of all garden and 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 a garden validation photographs that will be required for each plot.

PLATE 1 EXAMPLE PLOT COVER SYSTEM VALIDATION

Plot No: 70		
Depth of Strata (m bgl)	0.00-0.15	Validated TOPSOIL
	0.15-0.60	Validated SUBSOIL

Depth of Cover System Materials



Depth of Cover System Materials



Depth of Cover System at Ground Level



Depth of Cover System in Relation to Plot



9.2. GROUND GAS PROTECTION MEASURES

Ground gas monitoring to date suggests that the site will fall into the bracket for Characteristic Situation 2 / Amber which will require specialist mitigation measures to be constructed in accordance with BS8485 (2015)+A1(2019).

The validation inspection is to include the items that are detailed within Table 9.3.

TABLE 9.3 GROUND GAS MITIGATION MEASURES VALIDATION ITEMS

INSPECTION	METHOD
Product Verification	Confirmation that suitable products have been installed to consist of photographs of product types, labels on packaging and delivery tickets.
Wall Cavity Inspection	Confirmation that gas membrane spans the external wall cavity above the periscopic vents.
General Condition	The membrane is to be inspected to ensure there are no tears, punctures or rips.
Jointing	The engineer is to check the overlaps between membranes are correctly sealed with sufficient overlaps.
Service Entry Points	Verification of the presence of preformed tophats sealed to the pipe and membrane as per the construction detail.
Passive Venting Systems	The engineer should verify the presence of vents at 2m centres on at least 3 of the external walls. Verification of the stone venting layer and presence of pipes to be supplied by photographic records from site.

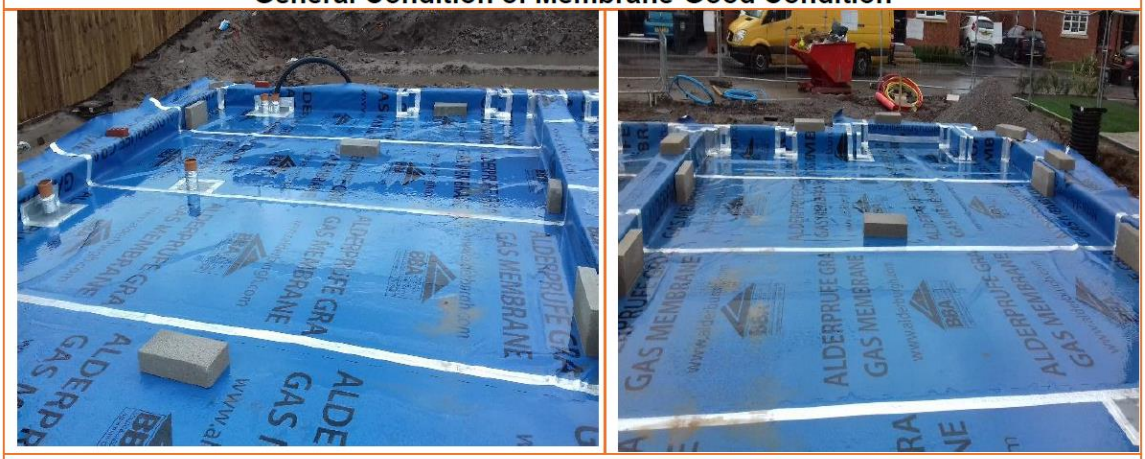
Examples of gas membrane verification photographs provided in Plate 2.

It should be noted that these are for illustrative purposes only as each site will have a site-specific gas membrane specification.

PLATE 2 EXAMPLE GAS MEMBRANE VERIFICATION

Plot – 236

General Condition of Membrane-Good Condition



Verification of Joints and Seals-Good Condition



Verification of Service Penetrations-Good Condition



9.3. 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

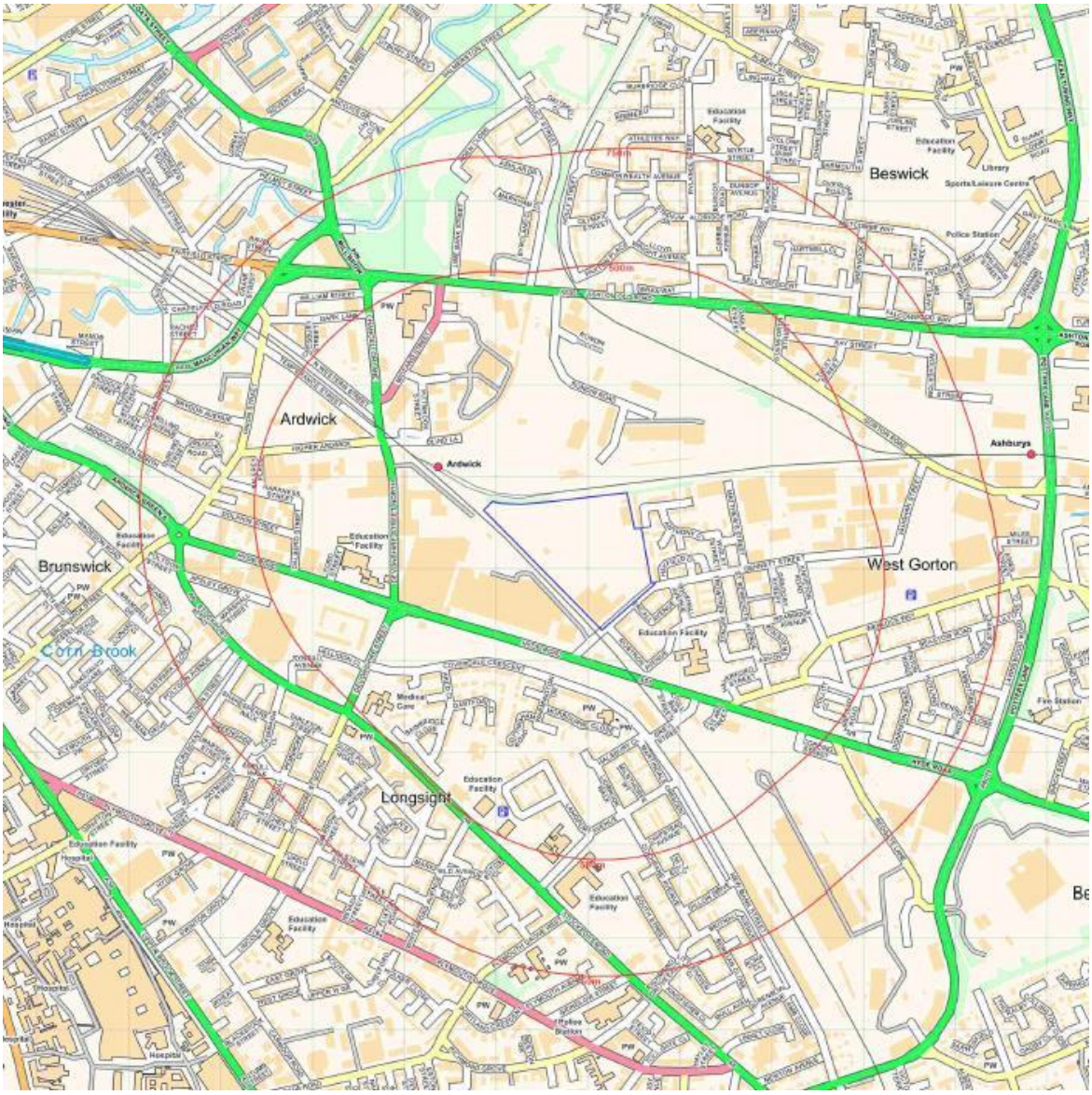
TERMS

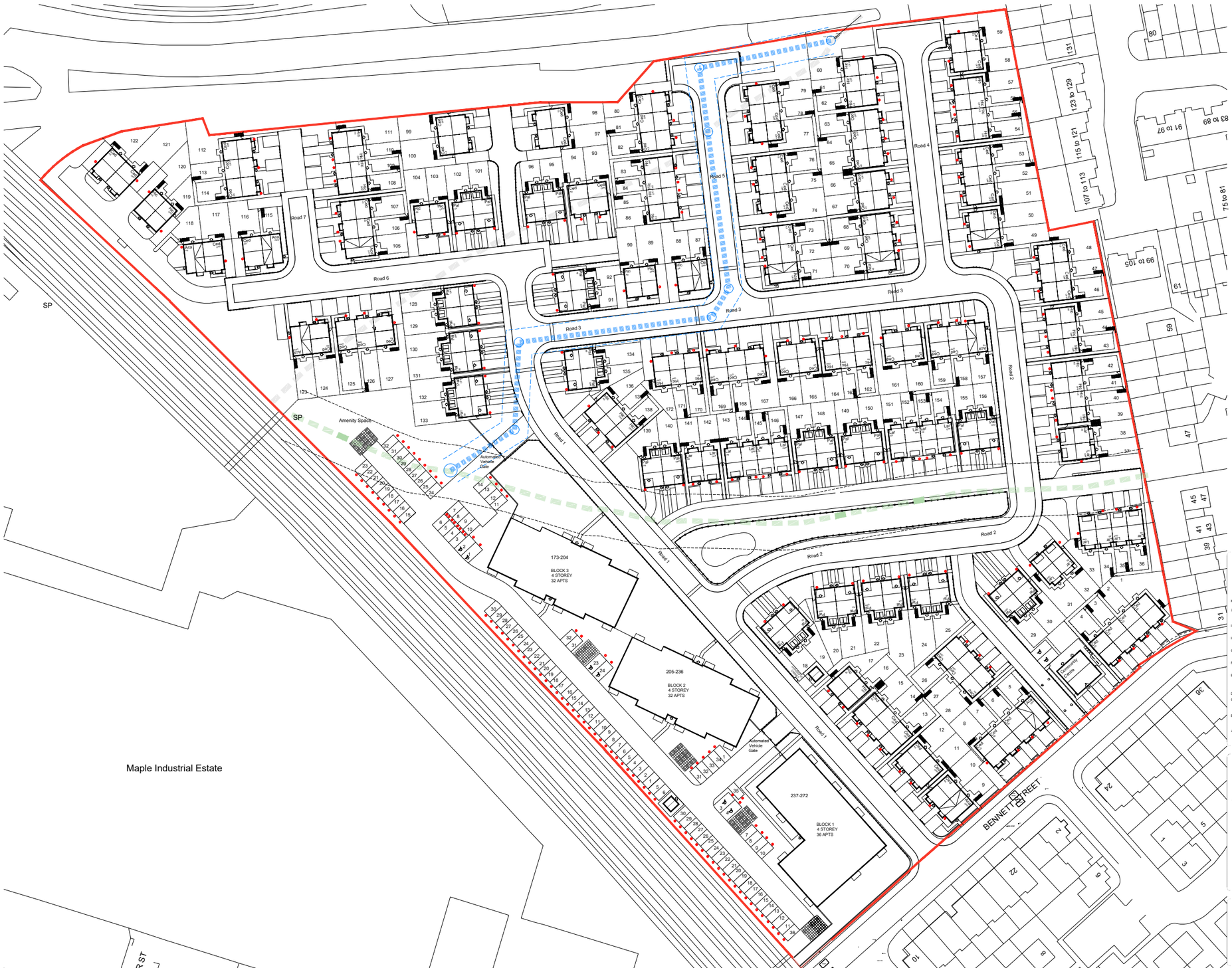
ACM	Asbestos-containing material	**MMP**	Materials management plan
ADS	Acoustic design statement	**ND**	Not detected
AST	Above-ground storage tank	**NDP**	Nuclear density probe
BGS	British Geological Survey	**NMP**	Noise management plan
BSI	British Standards Institute	**NPSE**	Noise policy statement 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/m^3**	Milligram per metre cubed
% v/v	Percent volume in air	**m bgl 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/m^2**	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

DRAWING 15-425-001 – SITE LOCATION PLAN





P1	REVB	19.04.2023	EB	MD
P1	REVA	21.07.2022	EB	MD
Phase	Issue	Date	Drawn	Checked

Notes:

Client:
Kellen Homes

Job No:
15-974

Date:
19.04.2023

Drawing No:
002

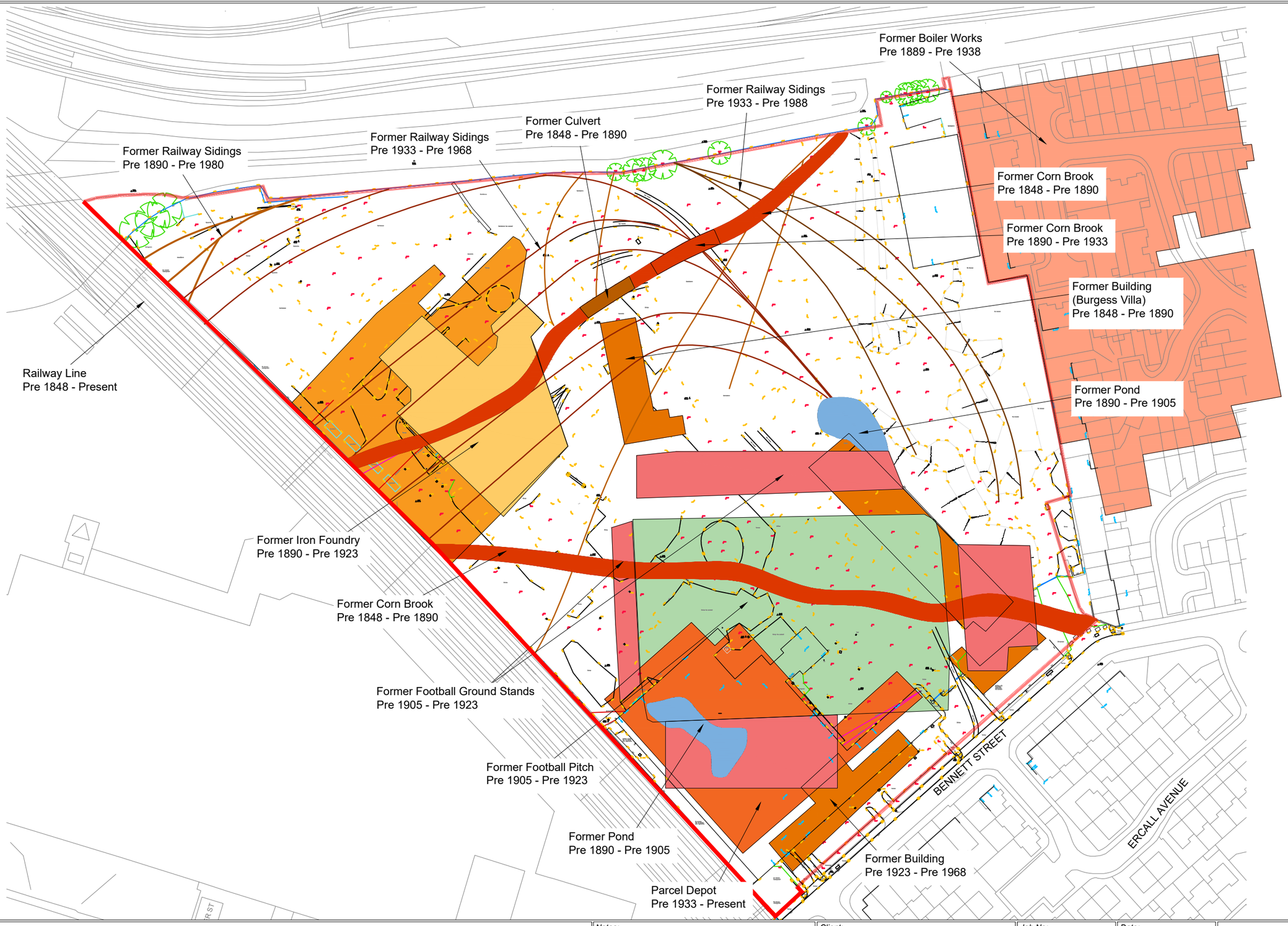
Scale:
NTS@ A3

Job Title:
Bennett Street, Manchester

Drawing Title:
Proposed Development Plan

e3p
Environmental Engineering Partnership Ltd
Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
E-mail: info@e3p.co.uk
Website: www.e3p.co.uk

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Historical Features

- Iron Foundry
- Iron Foundry Warehouse
- Buildings
- Culverts
- Ponds
- Football Pitches
- Football Stadium Stands
- Parcel Depot
- Boiler Works
- Culvert
- Railway Sidings
- Railway Sidings
- Railway Sidings

Notes:

Client: Kellen Homes

Job No: 15-974

Date: 29.03.2022

Drawing No: 003

Scale: NTS@ A3

Phase	Issue	Date	Drawn	Checked
P1	REVB	29.03.2022	LM	NS
P1	REVA	06.01.2022	LM	OJ

Job Title: Bennett Street, Manchester

Drawing Title: Historical Features Plan

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Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
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Website: www.e3p.co.uk

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Site Features

- Derelict Warehouse
- Warehouse
- Standing Water
- Vegetation
- Main Entrance
- Blocked Entrance
- Hardstanding
- Road
- Tank
- Existing Office Building
- Containers
- Waste / Scrap
- Overhead Services
- Aggregate Stockpile
- Tyres

Notes:

P1	REVB	06.04.2022	HM	OJ
P1	REVA	05.01.2022	LM	OJ
Phase	Issue	Date	Drawn	Checked

Client: Kellen Homes

Job No: 15-974

Date: 06.04.2022

Drawing No: 004

Scale: NTS@ A3

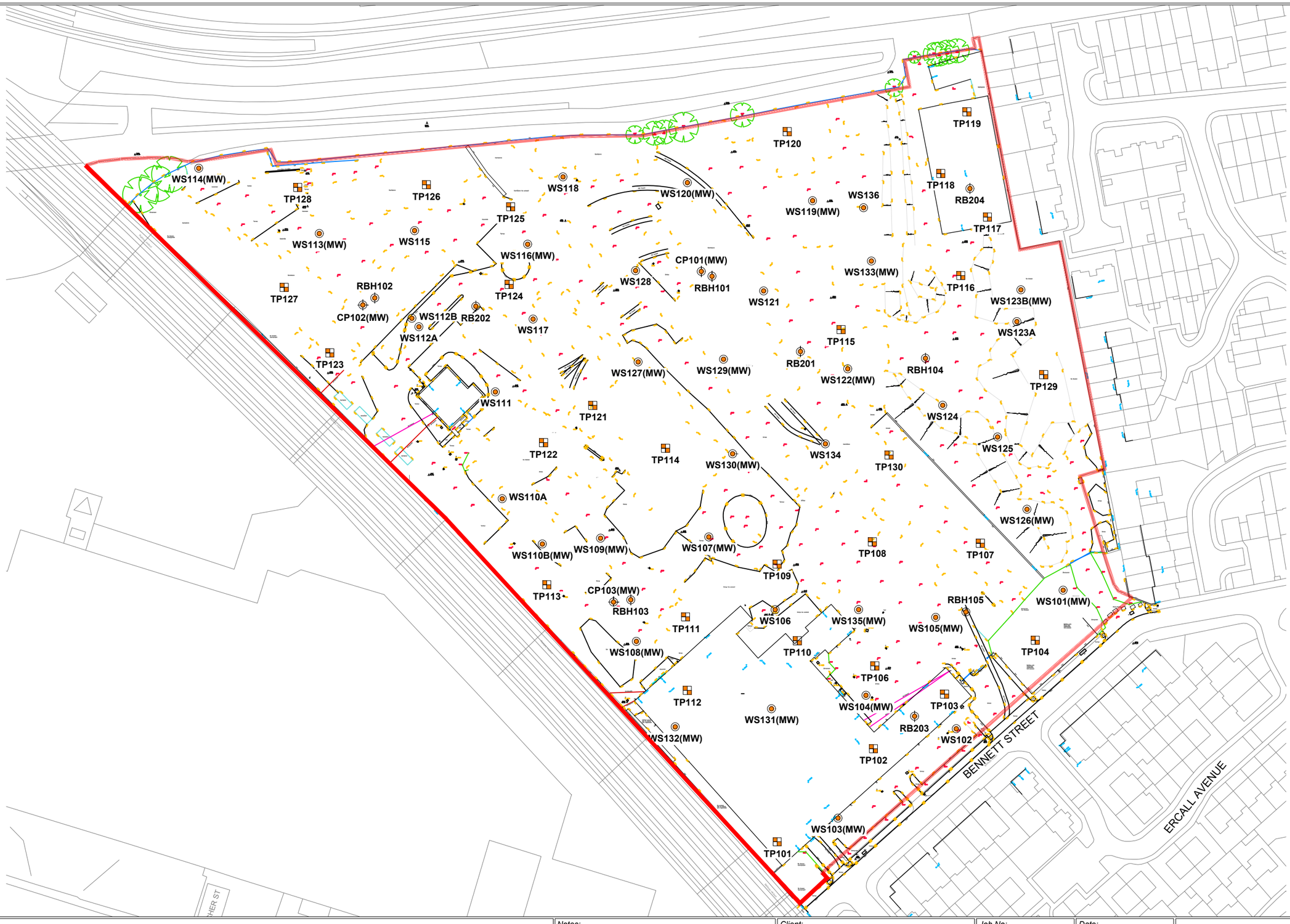
Job Title: Bennett Street, Manchester

Drawing Title: Site Features Plan

e3p

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Location Symbols

- WS101 — Approximate Window Sample Probehole Location
- WS101(MW) — Approximate Window Sample Probehole Location with Install
- CP101 — Approximate Cable Percussive Borehole Location
- RB101 — Approximate Rotary Borehole Location
- TP101 — Approximate Trial Pit Location

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVI	31.10.2022	EB	NS
P1	REVH	21.10.2022	EB	SE
P1	REVG	14.03.2022	HM	OJ
P1	REVF	26.01.2022	LM	OJ
P1	REVE	13.01.2022	LM	EC
P1	REVD	10.01.2022	LM	EC
P1	REVC	04.01.2022	CB	EC
P1	REVB	21.12.2021	EB	EC
P1	REVA	02.12.2021	LM	MD

Client: Kellen Homes

Job No: 15-974

Date: 31.10.2022

Drawing No: 005

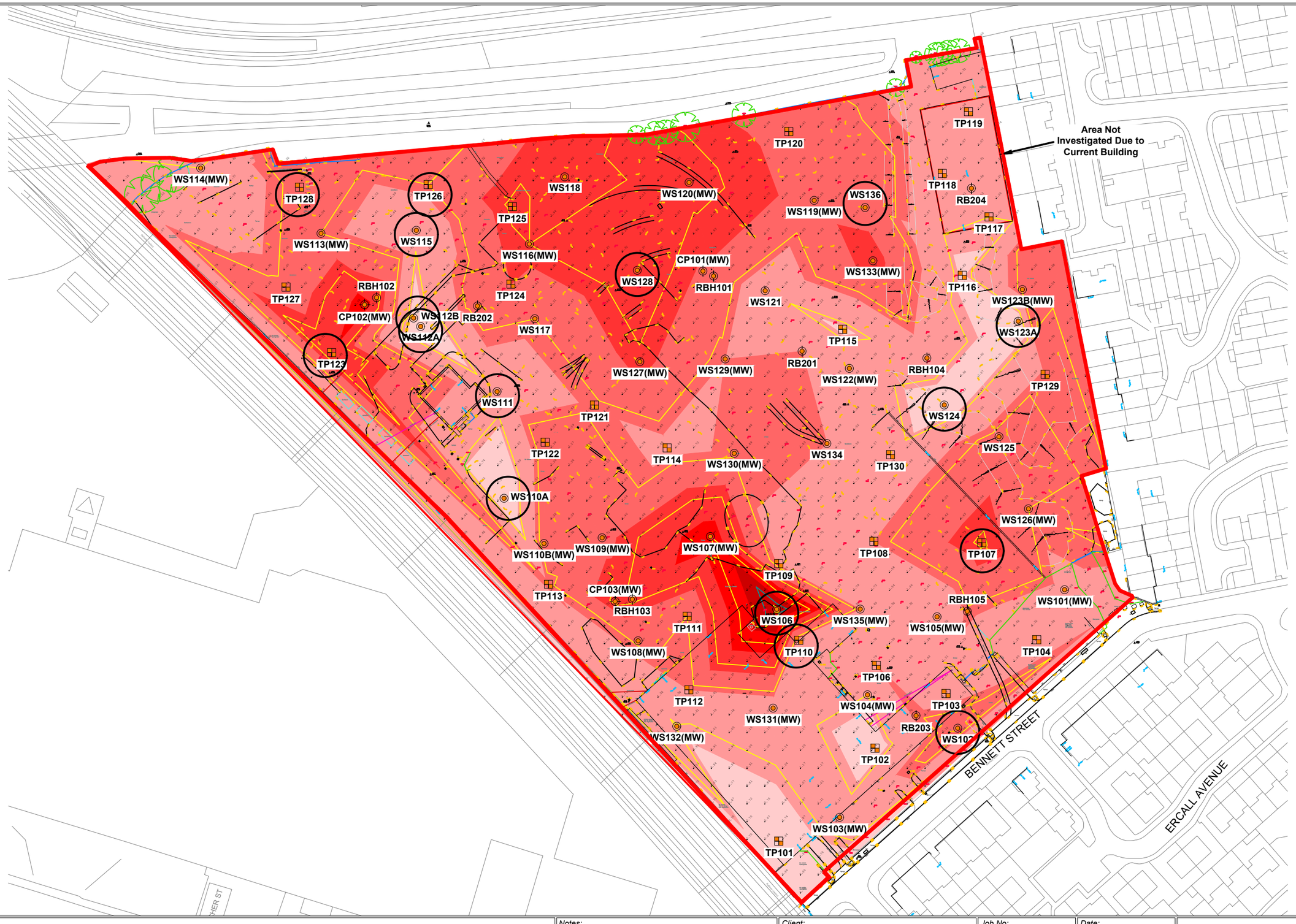
Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Exploratory Hole Location Plan

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Cable Percussive Borehole Location
- Approximate Rotary Borehole Location
- Full Extent of Made Ground not proven

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.89m
- Depth of Made Ground 0.90 - 1.49m
- Depth of Made Ground 1.50 - 2.09m
- Depth of Made Ground 2.10 - 2.69m
- Depth of Made Ground 2.70 - 3.29m
- Depth of Made Ground 3.20 - 4.09m
- Depth of Made Ground 4.10 - 4.99m
- Depth of Made Ground 5.00 - 5.89m
- Depth of Made Ground >5.90m

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	09.11.2022	EB	HM
P1	REVA	14.03.2022	HM	OJ

Client: Kellen Homes

Job No: 15-974

Date: 09.11.2022

Drawing No: 006

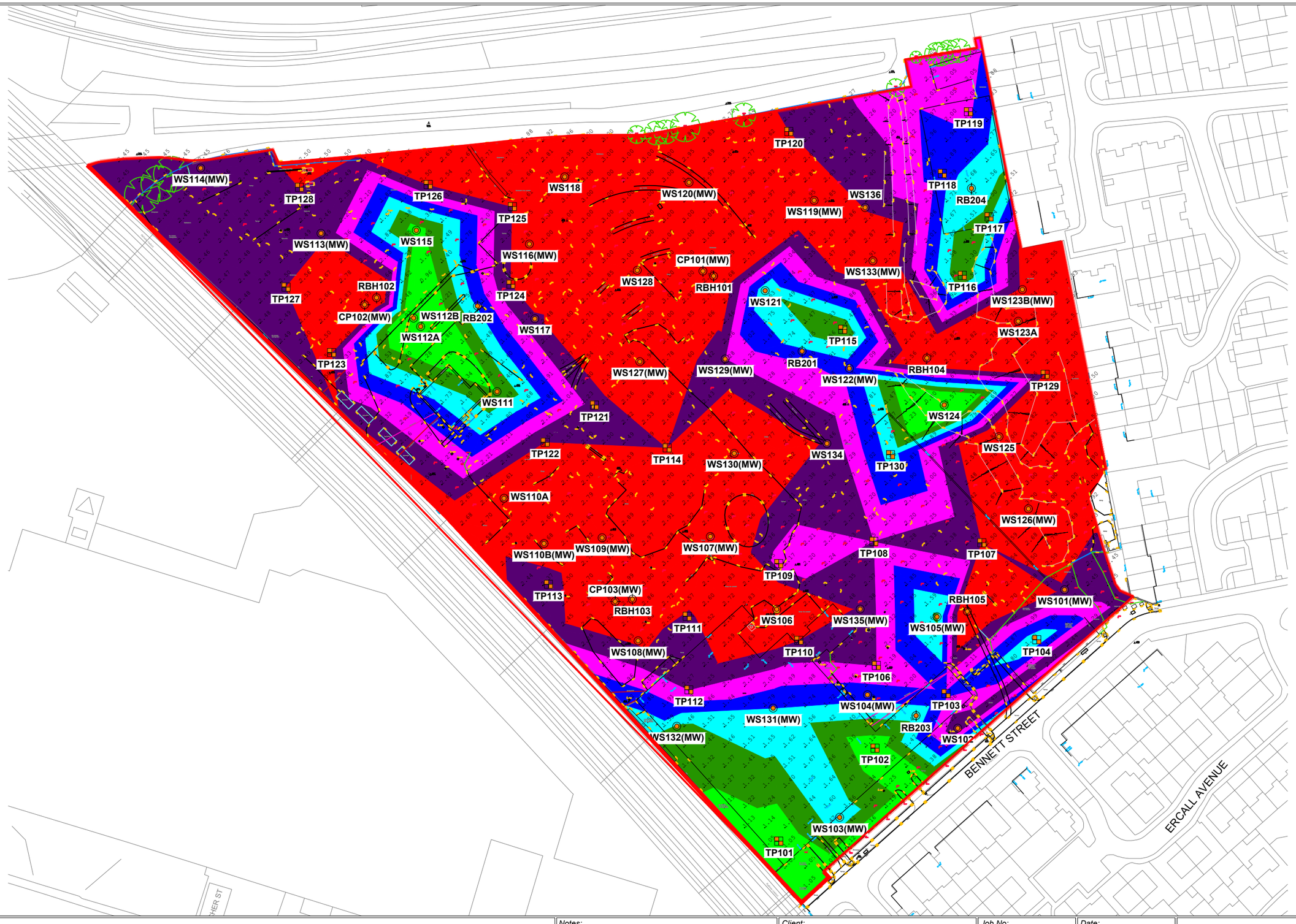
Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Depth of Made Ground Plan

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Location Symbols

- WS101 — Approximate Window Sample Probehole Location
- WS101(MW) — Approximate Window Sample Probehole Location with Install
- CP101 — Approximate Cable Percussive Borehole Location
- RB101 — Approximate Rotary Borehole Location

Shallow Spread Footings

- Depth to Founding Strata 0.00 - 1.24m
- Depth to Founding Strata 1.25 - 1.49m

Mass Trench Fill Footings

- Depth to Founding Strata 1.50 - 1.74m
- Depth to Founding Strata 1.75 - 1.99m
- Depth to Founding Strata 2.00 - 2.24m

Engineered Footings

- Depth to Founding Strata 2.25 - 2.49m
- Depth to Founding Strata >2.50m

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	24.11.2022	LM	MD
P1	REVA	24.03.2022	LM	OJ

Client: Kellen Homes

Job No: 15-974

Date: 24.11.2022

Drawing No: 008

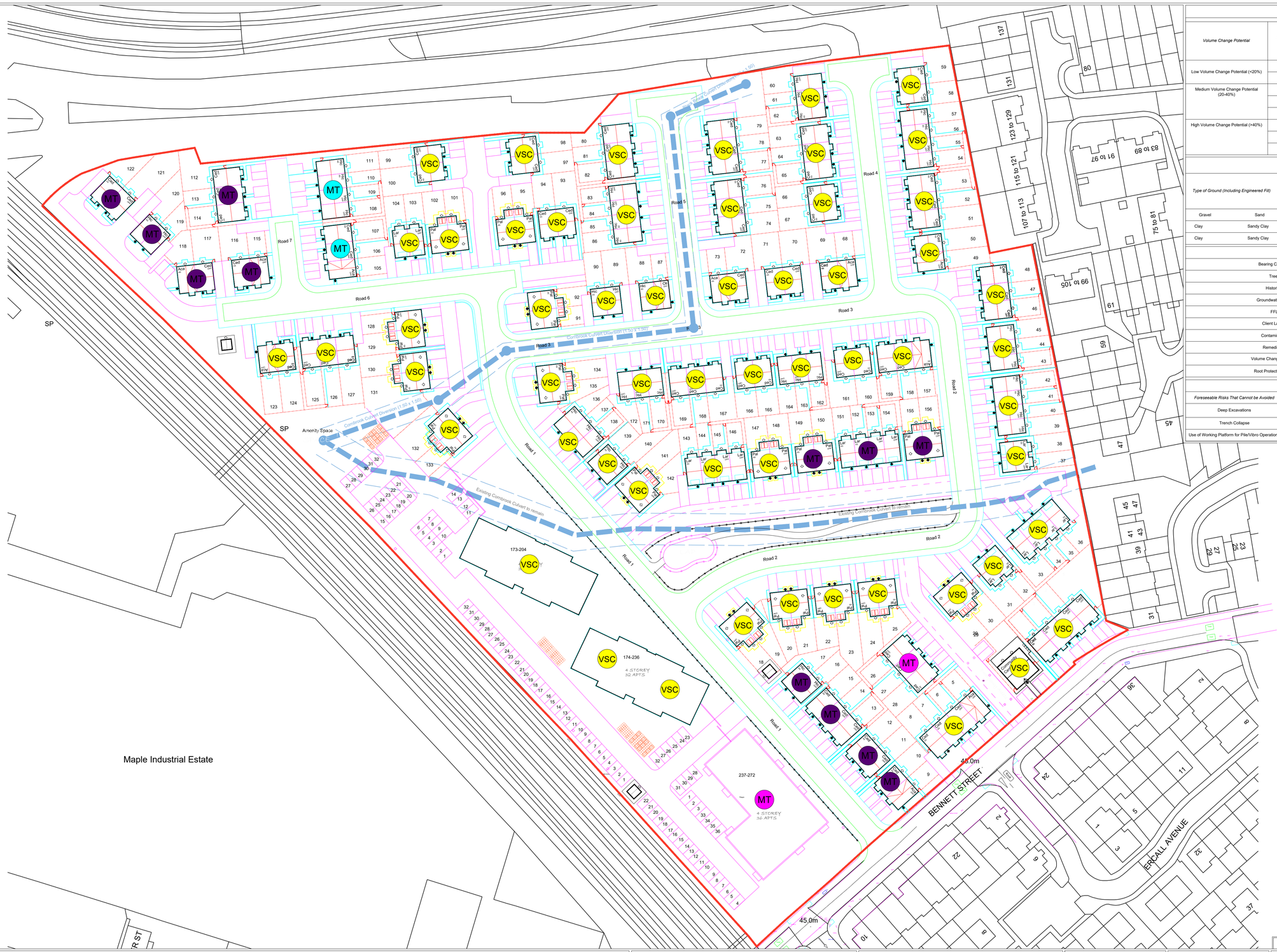
Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Depth to Founding Strata Plan

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Summary of Heave Precaution Requirements

Volume Change Potential	*Required Foundation Depth (m)*	*Minimum Void Dimensions for Foundations, Ground Beams & Suspended In-Situ Concrete Ground Floors*		*Minimum Void Dimensions Under Pre-Cast Concrete & Suspended Timber Floors*
		Thickness of Void Former Against Side of Foundation of Ground Beam (mm)	*Thickness of Void Former on Underside of Edge Beam & Floor Slab (mm)*	*Void Dimension (mm)*
Low Volume Change Potential (<20%)	>2.00	No Special Precautions		200
	2.00-2.50	-	50	
Medium Volume Change Potential (20-40%)	1.50-2.00	25	50	250
	2.00-2.50	25	100	
	>2.50	Engineer Design		Engineer Design
High Volume Change Potential (>40%)	1.50-2.00	25	75	300
	2.00-2.50	35	150	
	>2.50	Engineer Design		Engineer Design

Minimum Width of Strip Footings

Type of Ground (Including Engineered Fill)		*Condition of Ground*	*Total Load of Load-Bearing Walling more than (kN/linear metre)*					
			20	30	40	50	60	70
			Minimum Width of Strip Foundation (mm)					
Gravel	Sand	Medium Dense to Dense	250	300	400	500	600	650
Clay	Sandy Clay	Stiff	250	300	400	500	600	650
Clay	Sandy Clay	Firm	300	350	450	600	750	850

Items Considered

Bearing Capacity	TBC
Trees	TBC
Historical	TBC
Groundwater Table	TBC
FFL	TBC
Client Layout	TBC
Contamination	TBC
Remediation	TBC
Volume Change Potential	TBC
Root Protection Areas	TBC

Residual Risks

Foreseeable Risks That Cannot be Avoided	*Applicable (Y/N)*	*Action to Reduce Risk*	*Justification for Design Decision*
Deep Excavations	Y	Identify locations on drawing and depths on schedule	Lesser risk than other alternatives
Trench Collapse	Y	Risk highlighted on drawing	Lesser risk than other alternatives
Use of Working Platform for Pile/Vibro Operations	Y	Compliance with working platform directive required	Pile/Vibro foundation less risky than other alternatives

Anticipated Foundation Types

- TS — Traditional Strip Foundations. Minimum depth 900mm below proposed Final Finished Level. Maximum safe bearing pressure limited to 100kN/m2.
- MT — Mass Trench Fill Foundations. Minimum depth 1250mm below proposed Final Finished Level. Maximum safe bearing pressure limited to 100kN/m2.
- V — Vibro Stone Ground Compaction. In accordance with NHBC Chapter 4.2
- P — Piled Foundations. Where the maximum foundation depth exceeds 2.50m a piled foundation option rather than a trench fill / deep reinforced strip foundations may be adopted. Column or line loads supported by ground beams.
- R — Raft Foundations. Maximum safe bearing pressure limited to 50kN/m2 on approved engineered granular fill. Raft foundations to be designed by a structural engineer in accordance with Chapter 4.5 of NHBC 2013. Raft foundations are considered suitable to mitigate against potential influence of clay heave / desiccation in accordance with Section 4.2, sub section D7E.
- TB — Traditional Strip / Trench Block Foundations. Traditional strip founded at 450mm below current level with build up in Trench Block and subsequent backfill to development level.
- Colours on Plot Corners to be Used When Referring to Foundation Schedule. (Pending Final Layout & Levels)

Depth to Target Founding Strata

- Footings 0.75 - 0.90m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 0.90 - 1.25m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 1.25 - 1.50m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 1.50 - 1.75m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 1.75 - 2.00m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 2.00 - 2.25m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Footings 2.25 - 2.50m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2

Engineered Foundation Solutions

- Footings >2.50m Deep. From Final Finished Level. In accordance with NHBC Chapter 4.2
- Vibro
- Low Volume Change Potential Clay. Heave precautions required to underside of cast in-situ floor slab (with no sub-floor void) within conjected zone of tree influence. Heave precautions not required to foundation.

Tree Influence (Retained / Removed)

- 0.90 - 1.25m
- 1.25 - 1.50m
- 1.50 - 1.75m
- 1.75 - 2.00m
- 2.00 - 2.25m
- 2.25 - 2.50m
- >2.50m

Notes:

Client: Kellen Homes

Job No: 15-974

Date: 21.07.2022

Drawing No: 009

Scale: 1:1000 @ A1

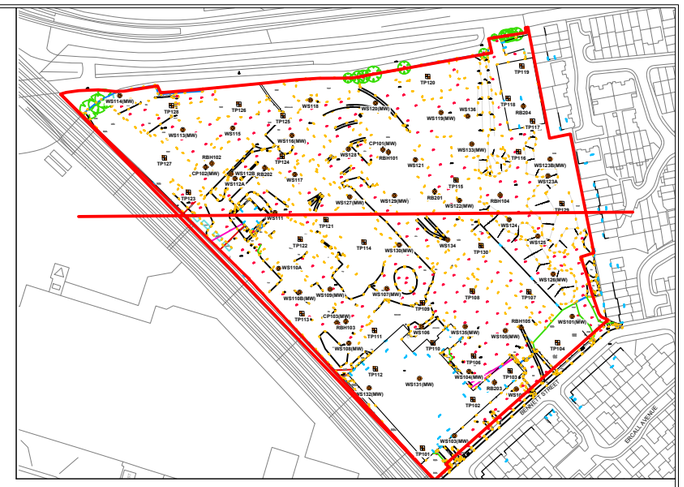
Phase	Issue	Date	Drawn	Checked
P1	REVC	21.07.2022	EB	MD
P1	REVB	12.07.2022	LM	MD
P1	REVA	24.03.2022	LM	OJ

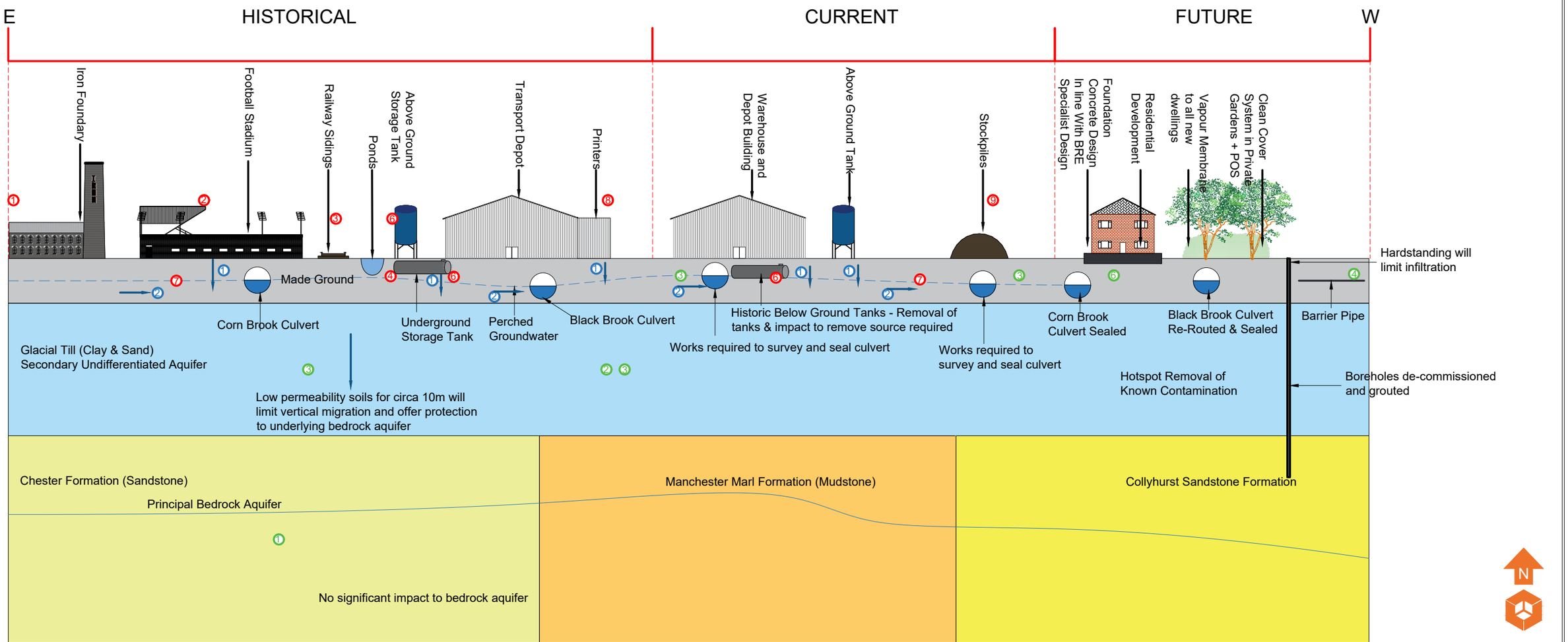
Job Title: Bennett Street, Manchester

Drawing Title: Concept Foundation Zoning Plan

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Geology Key

- Made Ground
- Glacial Till
- Collyhurst Sandstone
- Manchester Marl Formation
- Chester Formation

Sources

1. Iron Foundry (Heavy Metal, BTEX, VOC, SVOC, TPH, Asbestos)
2. Football Stadium (Heavy Metal, PAH, Asbestos, Ground Gas)
3. Railway Sidings (Heavy Metal, PAH, SVOC, VOC, Coal Tar)
4. Infilled Ponds (Heavy Metals, PAH, Asbestos, Ground Gas)
5. AST & UST (TPH, BTEX, PAH, VOC, SVOC)
6. AST & UST (TPH, BTEX, PAH, VOC, SVOC)
7. Made Ground (Heavy Metal, PAH, TPH, VOC, SVOC, BTEX, Asbestos, Coal Tar, Ground Gas)
8. Printers (Heavy Metal, PAH, VOC, SVOC, TPH)
9. Stockpiles (Heavy Metal, PAH, Asbestos, PCB's, TPH)

Pathway

1. Vertical migration through Made Ground
2. Lateral migration via perched water

Receptor

1. Groundwater Aquifer
2. Perched Groundwater
3. Surface Water Features (Culverts)
4. Water infrastructure

Notes:

P1	REVA	12.01.2023	HM	MD
Phase	Issue	Date	Drawn	Checked

Client: Kellen Homes

Job No: 15-974

Date: 12.01.2023

Drawing No: 010

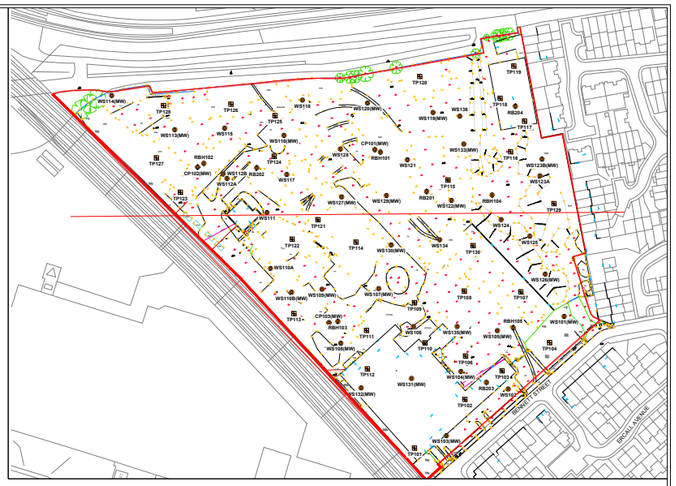
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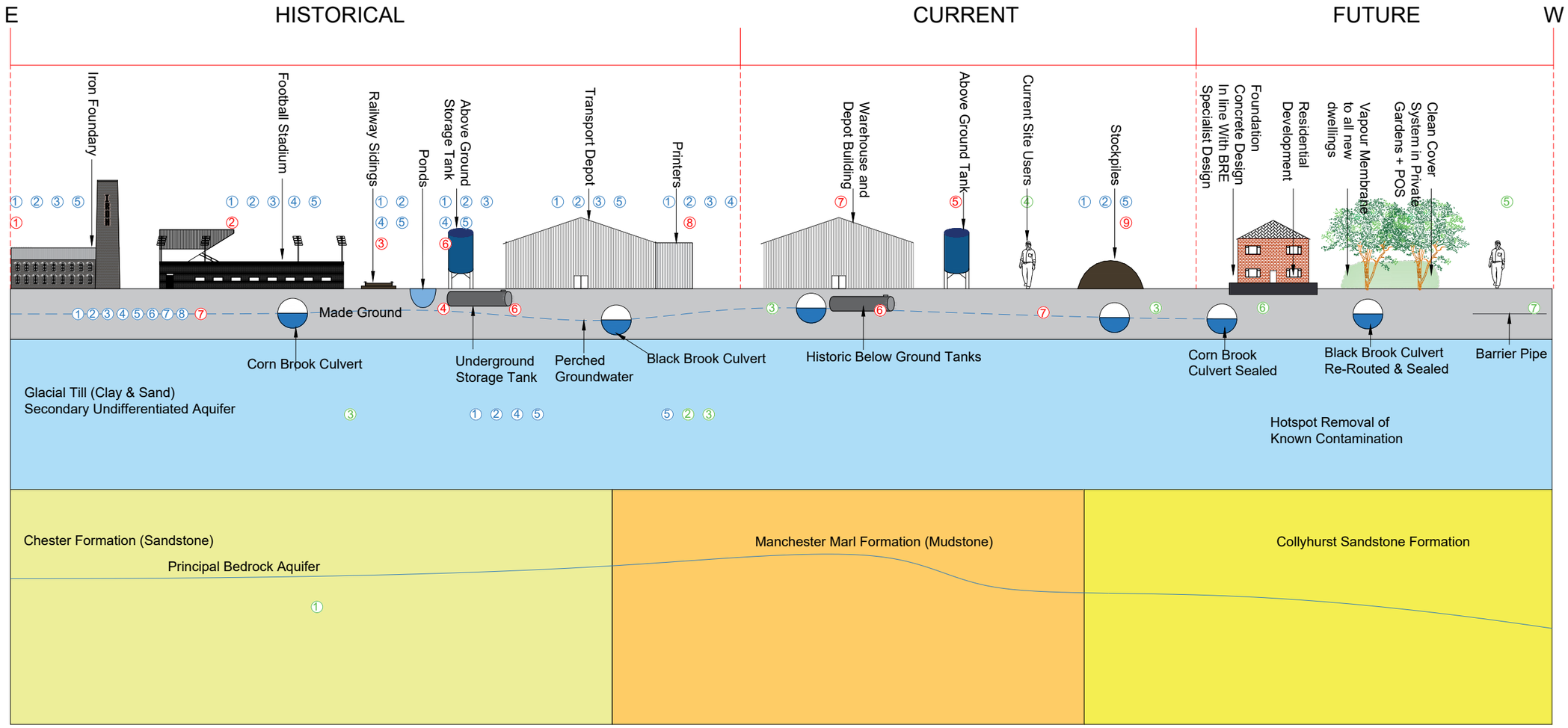
Job Title: Bennett Street, Manchester

Drawing Title: Conceptual Site Model (Groundwater)

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Geology Key

- Made Ground
- Glacial Till
- Collyhurst Sandstone
- Manchester Marl Formation
- Chester Formation

Sources

1. Iron Foundry (Heavy Metal, BTEX, VOC, SVOC, TPH, Asbestos)
2. Football Stadium (Heavy Metal, PAH, Asbestos, Ground Gas)
3. Railway Sidings (Heavy Metal, PAH, SVOC, VOC, Coal Tar)
4. Infilled Ponds (Heavy Metals, PAH, Asbestos, Ground Gas)
5. AST & UST (TPH, BTEX, PAH, VOC, SVOC)
6. AST & UST (TPH, BTEX, PAH, VOC, SVOC)
7. Made Ground (Heavy Metal, PAH, TPH, VOC, SVOC, BTEX, Asbestos, Coal Tar, Ground Gas)
8. Printers (Heavy Metal, PAH, VOC, SVOC, TPH)
9. Stockpiles (Heavy Metal, PAH, Asbestos, PCB's, TPH)

Pathway

1. Soil Ingestion
2. Dermal Contact and Ingestion
3. Dust Inhalation
4. Vapour / Gas Inhalation
5. Vertical / Lateral Migration
6. Corrosion of Concrete
7. Tainting Water Supply

Receptor

1. Groundwater Aquifer
2. Perched Groundwater
3. Surface Water Features (Culverts)
4. Current Site Users (Construction Workers)
5. Future Site Users
6. Building Foundations & Structures
7. Water Infrastructure

Notes:

P1	REVA	10.01.2023	HM	MD
Phase	Issue	Date	Drawn	Checked

Client: Kellen Homes

Job Title: Bennett Street, Manchester

Job No: 15-974

Date: 10.01.2023

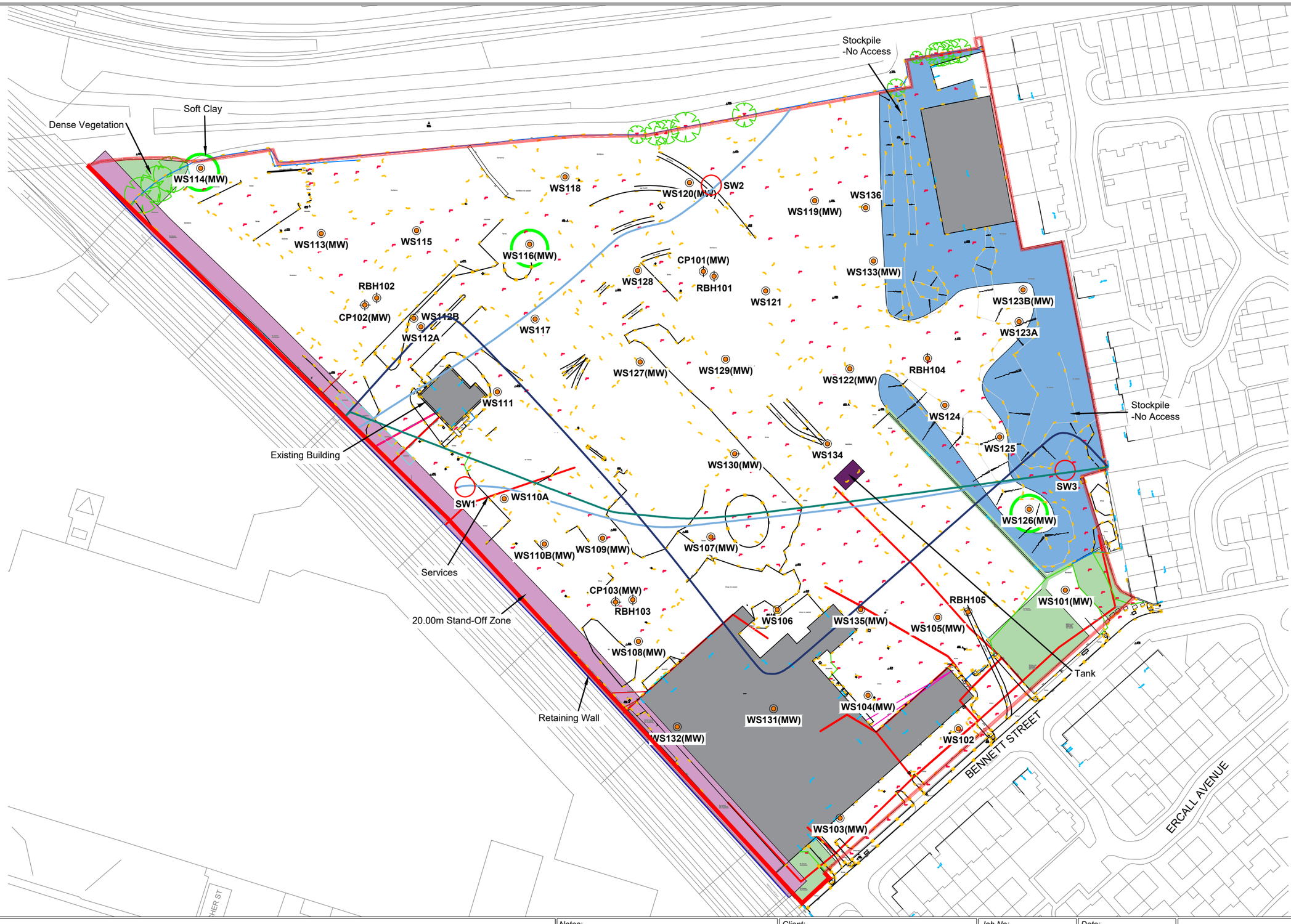
Drawing No: 010

Scale: NTS@ A3

Drawing Title: Conceptual Site Model

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Cable Percussive Borehole Location
- Approximate Rotary Borehole Location

Development Constraints

- Retaining Wall
- 20.00m Stand Off Zone
- Tank
- Existing Building
- Dense Vegetation
- Stockpile (No Access)
- Approximate Location of Services
- Soft Clay
- Culvert
- Indicates proposed route of culvert watercourse diversion via the central section of the new access roads.
- Indicates existing route of Corn Brook culvert
- Surface Water Monitoring Point

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	06.04.2022	HM	OJ
P1	REVA	14.03.2022	HM	OJ

Client: Kellen Homes

Job No: 15-974

Date: 06.04.2022

Drawing No: 012

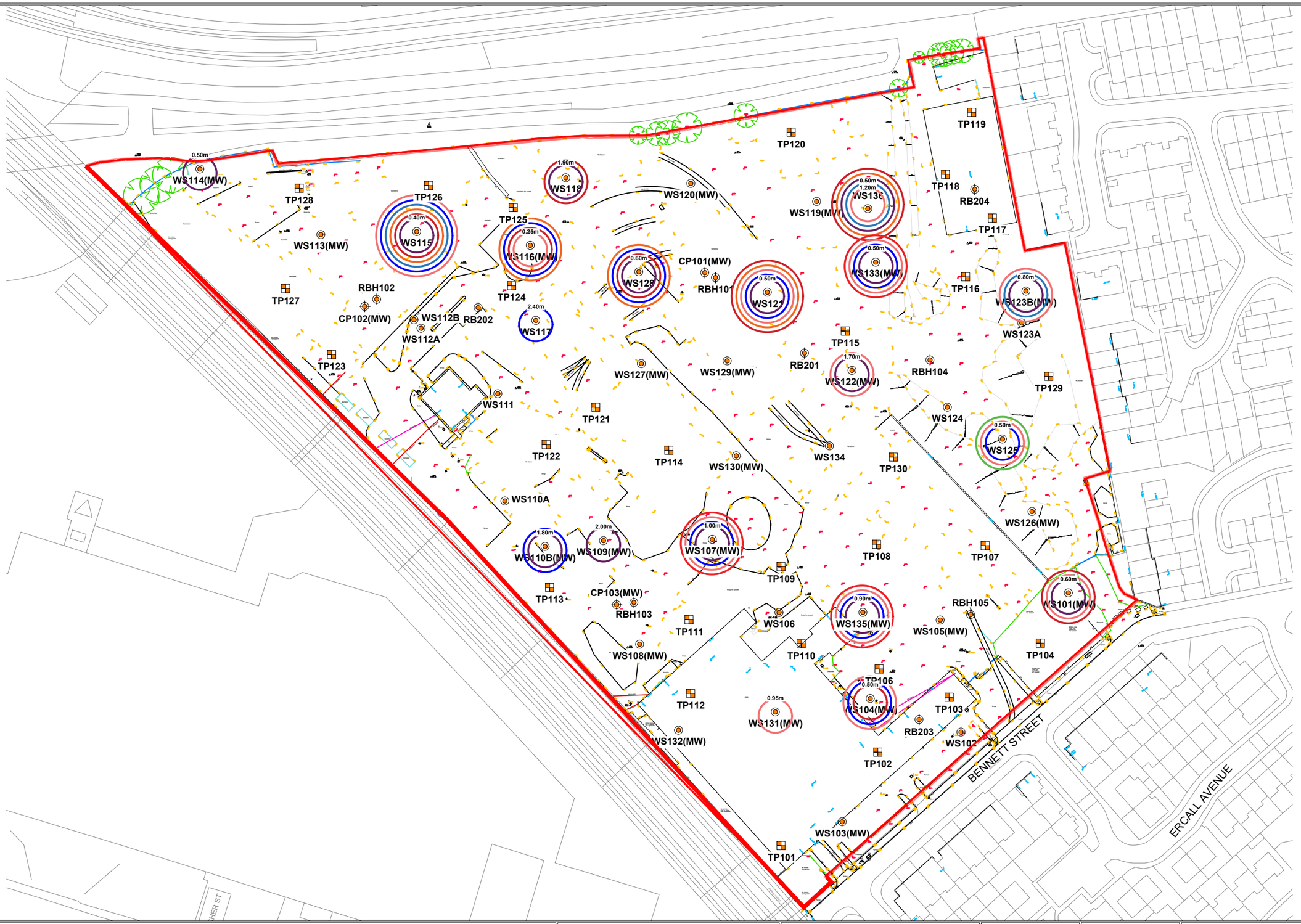
Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Development Constraints Plan

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Cable Percussive Borehole Location
- Approximate Rotary Borehole Location

Human Health

- PAH
- Metals
- Mercury
- SVOC
- Asbestos
- Napthalene
- TPH

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVB	24.11.2022	LM	MD
P1	REVA	14.03.2022	HM	OJ

Client: Kellen Homes

Job No: 15-974

Date: 24.11.2022

Drawing No: 013

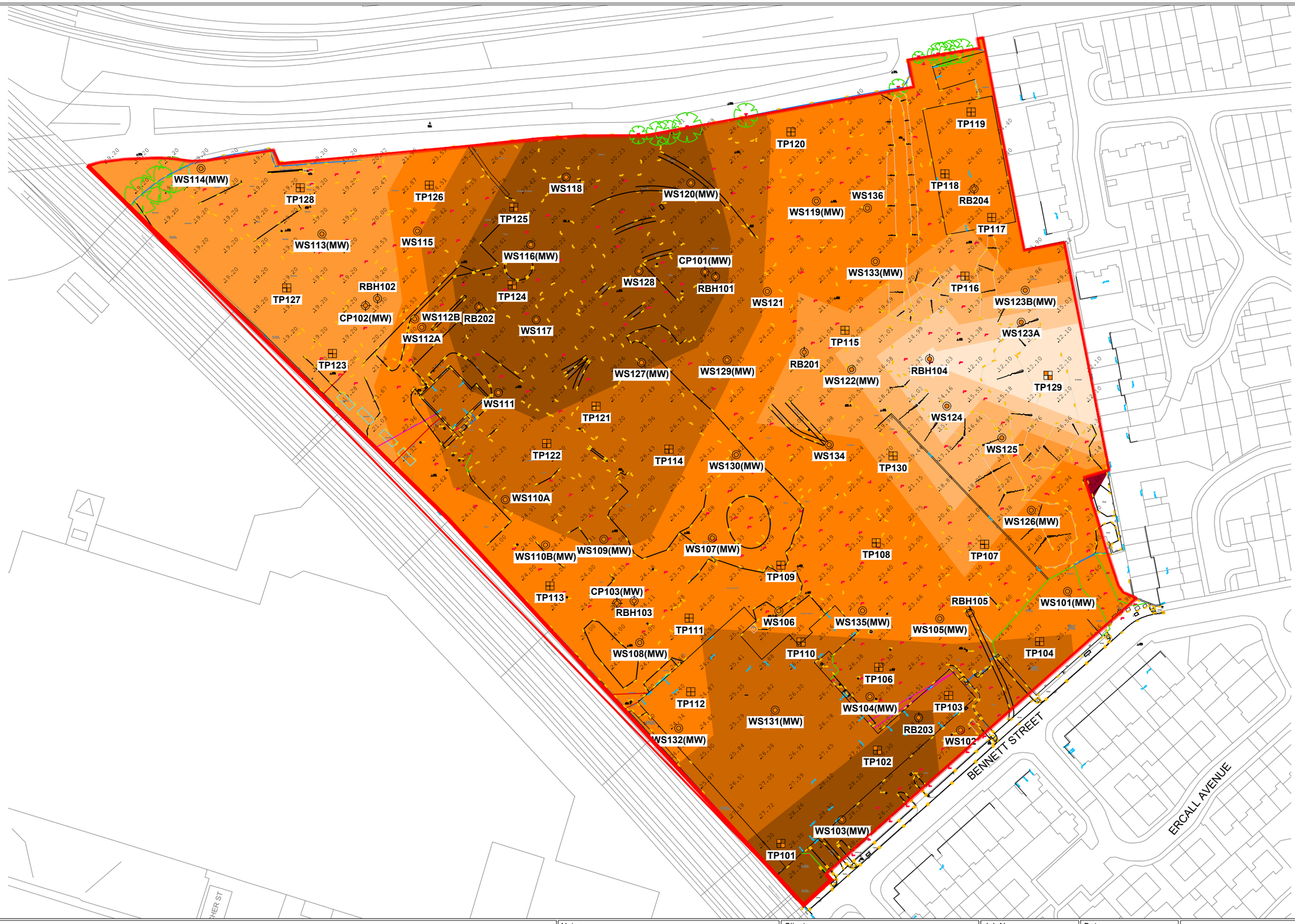
Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Human Health Exceedances Plan

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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Cable Percussive Borehole Location
- Approximate Rotary Borehole Location

Bedrock Depth (m)

- Depth to Bedrock 10.00 - 12.99m
- Depth to Bedrock 13.00 - 15.99m
- Depth to Bedrock 16.00 - 18.99m
- Depth to Bedrock 19.00 - 21.99m
- Depth to Bedrock 22.00 - 24.99m
- Depth to Bedrock 25.00 - 27.99m
- Depth to Bedrock >28.00m

Notes:

P1	REVB	08.11.2022	EB	HM
P1	REVA	14.03.2022	HM	OJ
Phase	Issue	Date	Drawn	Checked

Client: Kellen Homes

Job No: 15-974

Date: 08.11.2022

Drawing No: 014

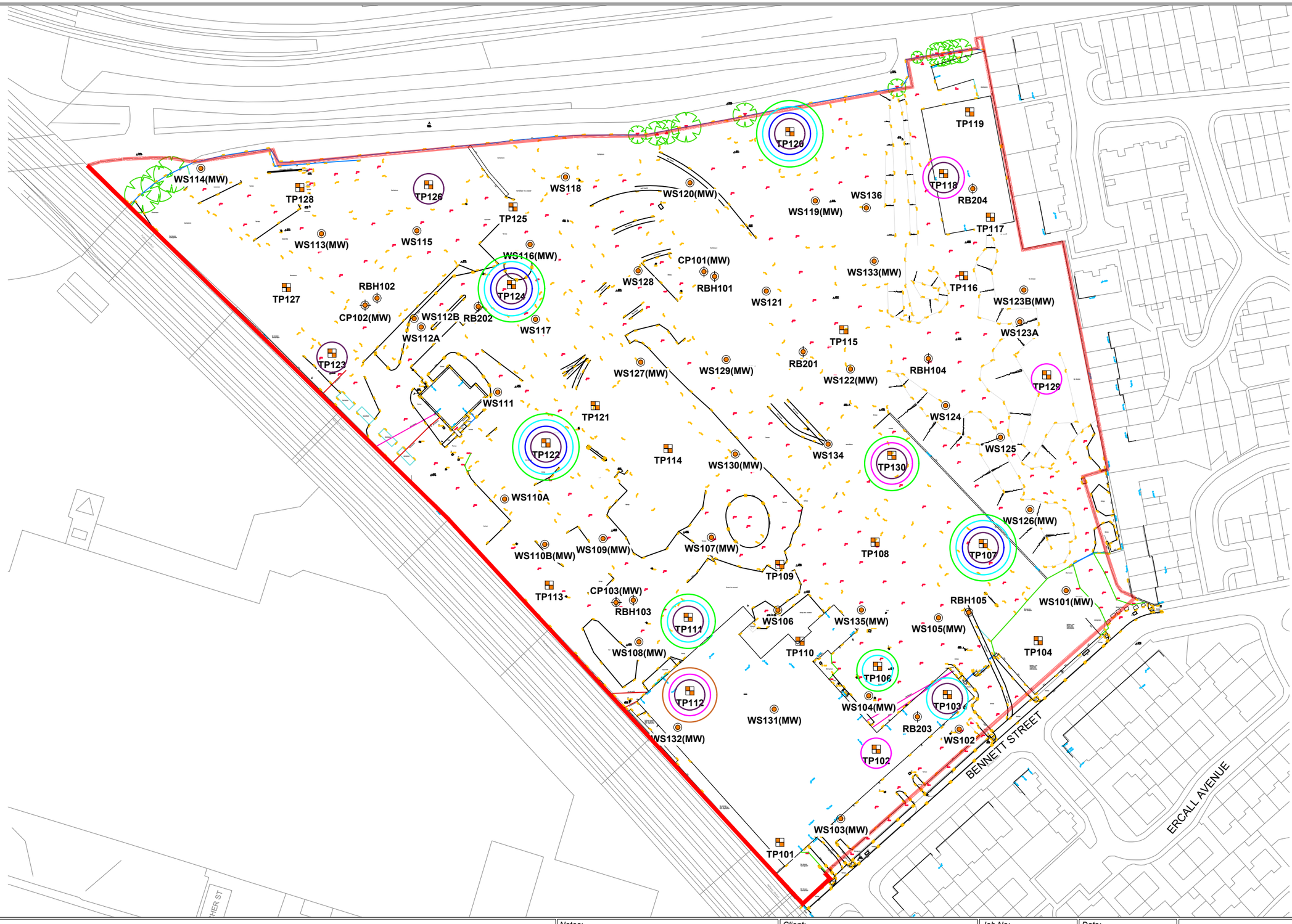
Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Depth to Bedrock Plan

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Location Symbols

- WS101 — Approximate Window Sample Probehole Location
- WS101(MW) — Approximate Window Sample Probehole Location with Install
- CP101 — Approximate Cable Percussive Borehole Location
- RB101 — Approximate Rotary Borehole Location
- TP101 — Approximate Trial Pit Location

Contamination Issues

- PAH
- Metals
- Mercury
- SVOC
- Naphthalene
- TPH

Notes:

P1	REVA	07.11.2022	EB	HM
Phase	Issue	Date	Drawn	Checked

Client: Kellen Homes

Job No: 15-974

Date: 07.11.2022

Drawing No: 018

Scale: NTS@ A3

Job Title: Bennett Street, Manchester

Drawing Title: Contamination Issues Plan

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Key

- Phase 1
- Phase 2

Notes:	Client:	Job No:	Date:
	Kellen Homes	15-974	23.01.2023
		Drawing No: 021	Scale: NTS@ A3

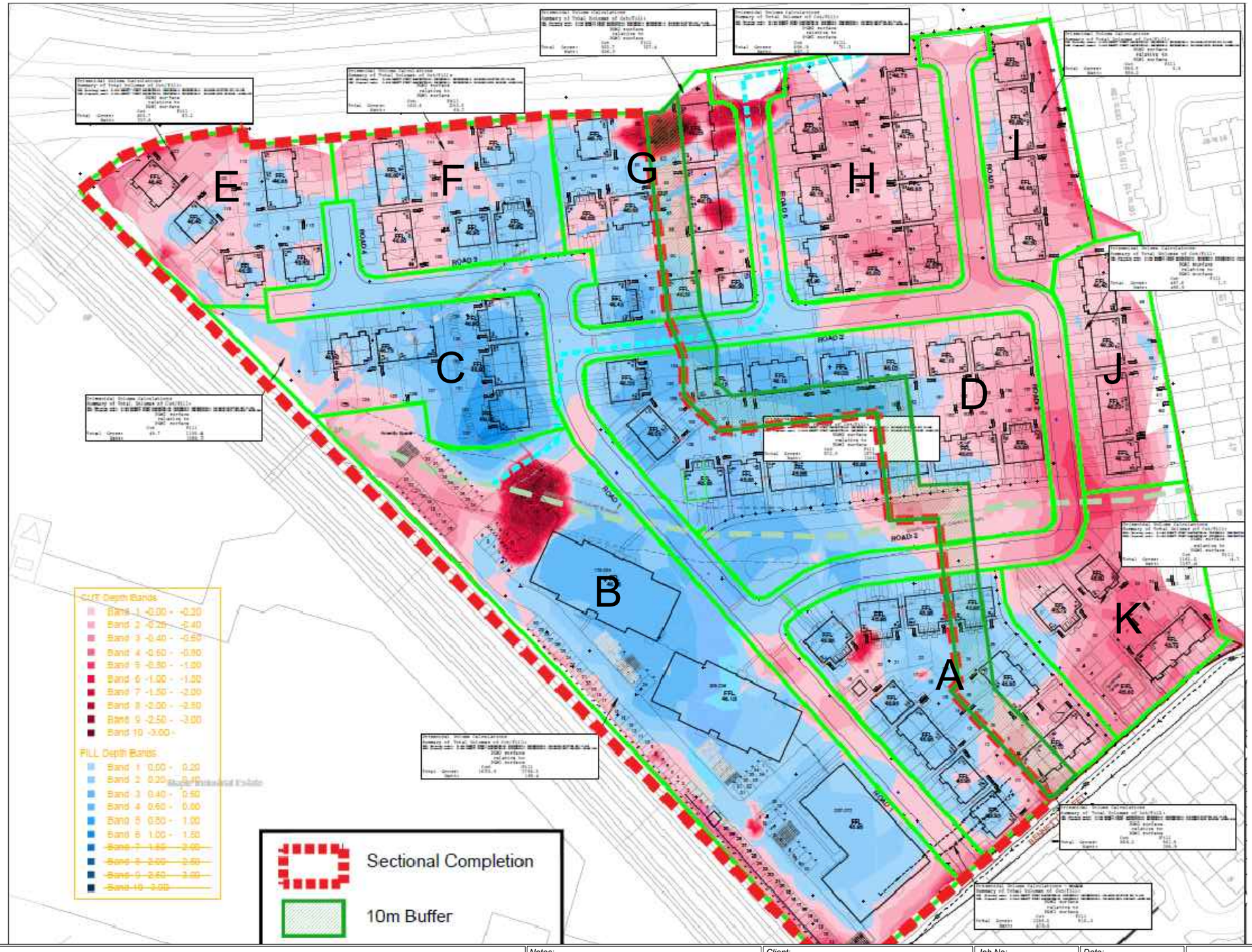
Phase	Issue	Date	Drawn	Checked
P1	REVA	23.01.2023	EB	MD

Job Title: Bennett Street, Manchester

Drawing Title: Remediation Phasing Plan and Culvert Diversion Plan

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P1	REVA	14.02.2023	EB	MD
Phase	Issue	Date	Drawn	Checked

Notes:

Client: Kellen Homes

Job No: 15-974

Date: 14.02.2023

Drawing No: 022

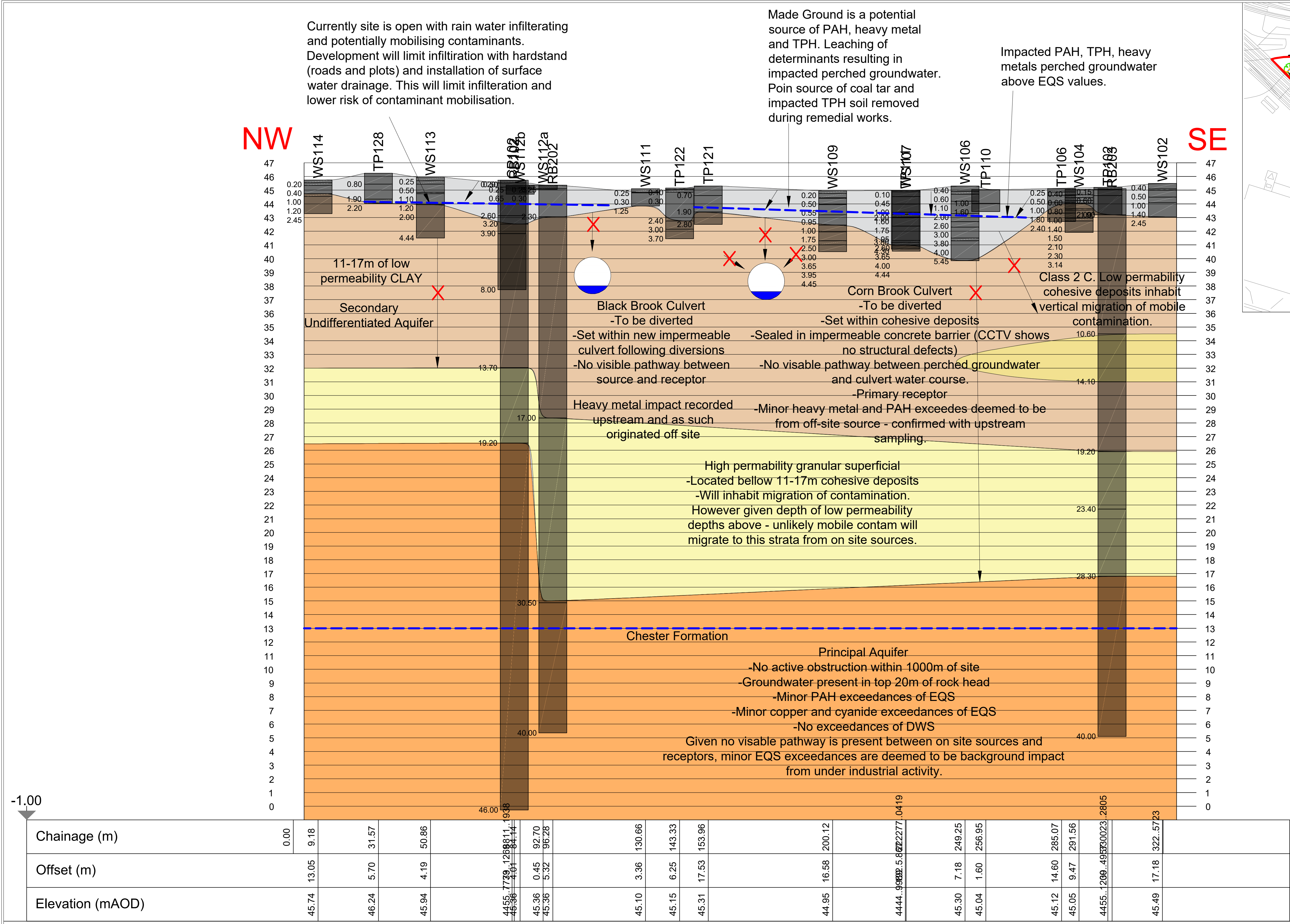
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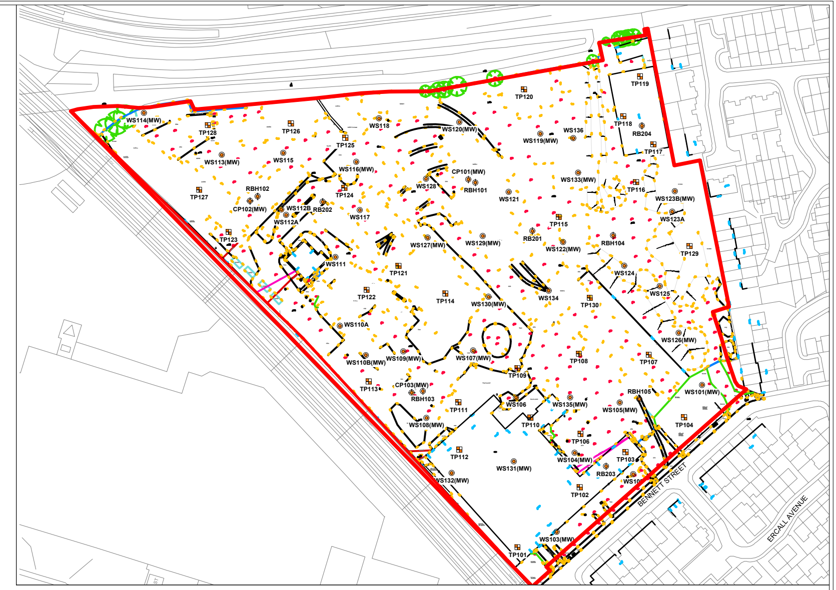
Job Title: Bennett Street, Manchester

Drawing Title: Remediation Sub-division and Works Requirement

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Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVC	11.05.2023	EB	MD
P1	REVB	05.05.2023	HM	MD
P1	REVA	27.04.2023	EB	MD

Client: Kellen Homes

Job Title: Bennett Street, Manchester

Job No: 15-974

Date: 11.05.2023

Drawing No: 026

Scale: NTS@ A3

Drawing Title: Waters Conceptual Site Model

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APPENDIX IV
E3P REMEDIATION/ VALIDATION CRITERIA

HUMAN HEALTH REMEDIATION TARGETS – LOW-RISE RESIDENTIAL END USE

DETERMINANT	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

TPH C_{12}-C_{16} (aromatic)	mg/kg	140[(i)(xi)]	1800[(ii)(xi)]	1800[(ii)(xi)]	10,000[(xiv)(xi)]	1
TPH C_{16}-C_{21} (aromatic)	mg/kg	260[(i)(xi)]	1900[(ii)(xi)]	1900[(ii)(xi)]	10,000[(xiv)(xi)]	1
TPH C_{21}-C_{35} (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 Suitable 4 Use Levels (S4ULs) for residential end use with plant uptake.
ii. Value derived from LQM Suitable 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 Suitable 4 Use Levels (S4ULs) for public open space (POS) residential.
iv. Value derived from LQM Suitable 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 Suitable 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 Suitable 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

DETERMINANT	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

DETERMINANT	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 (m^3)	
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 Hotpots, 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.