



Remediation and Enabling Works Strategy
Pacific Park, Wrexham

Reference:14-255-R4-1
Date: July 2021



REMEDIATION AND ENABLING WORKS STRATEGY

Land to the South of Bridge Road North
Pacific Park
Wrexham
LL13 9PN

Prepared for:

Multimag Limited

Report Ref: 14-255-R4-1

Date Issued: July 2021



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QUALITY ASSURANCE

PROJECT NUMBER	14-255		
VERSION	Version 1	Version 2	
REMARKS	Final	Update as per comment from Wrexham Borough Council	
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ISO 9001 (2015)
ISO 14001 (2015)
ISO 45001 (2018)



Cert No 18890

EXECUTIVE SUMMARY

Site Address	Land south of Bridge Road North, Pacific Park, Wrexham, LL13 9PN
National Grid Reference	E338540 N349910
Site Area	0.62 Hectares
Background	This document provides a comprehensive specification for the land remediation and subsequent enabling earthworks including geotechnical performance criteria required to ensure the construction of a development platform that will be geotechnically suitable for the proposed commercial and industrial end use. The specification defines the land remediation works required to ensure all potential unacceptable risk associated with identified contamination is addressed to ensure no complete pollution linkage upon completion of the development. This specification defines geotechnical parameters for the up-fill of soils as a structural fill, compaction of materials to construct a sub-base using stabilised and solidified recycled materials or imported aggregate and requirement for processing aggregates to ensure compliance with the necessary engineering properties.
Proposed Development	E3P understands that the proposed development will comprise of two industrial units with associated access roads, external yard areas, parking, haulage turning circles and utility infrastructure.
Site Investigation Reports & Assessment	This Remediation Strategy & Geotechnical Enabling Works Specification has been prepared in due consideration of the E3P Phase 1 Geoenvironmental Site Assessment (Ref: 14-255-R1-1, dated July 2020) and E3P Phase 2 Site Investigation report (Ref: 14-255-R2-1) dated May 2021. All Site Investigation reports should be read as a precursor to this document.

CONTAMINATED LAND ASSESSMENT

Human Health Risk Assessment	A Tier I human health risk assessment has been undertaken using the chemical analysis results of the soils and comparing to the relevant Tier I criteria for a commercial development. This assessment has identified the presence of elevated levels of asbestos, non-volatile PAHs, PCBs and detectable SVOC presence. All of the identified elevated concentrations have primary exposure pathways related to dermal contact and ingestion of soils, inhalation of particulate and inhalation of vapours. The risk to chronic human health associated with the elevated concentrations of non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all, landscaping and public open space to remove any potential for direct exposure to impacted soils or for the commercial premises covered by suitable hardstanding. Asbestos in the form of chrysotile and amosite has also been identified within localised areas in shallow Made Ground deposits. Asbestos quantification has been completed with concentrations between <0.001% and 0.002%. No visual signs of ACM were encountered during the ground investigation; it is therefore likely that only trace fibres are present. It is likely that trace fibres are present within all Made Ground deposits on site. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model. Asbestos has
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Human Health Risk Assessment Cont.	been identified in WS101 and TP108 at a concentration of 0.002%. These areas should therefore be isolated and undergo a phase of delineation and hotspot removal with placement within an area of low sensitivity in line with the asbestos risk mitigation conceptual site model. PCBs have been identified within Made Ground and CLAY drift deposits within WS101. It is considered there are site wide PCBs and as such the materials will be suitable for retention on site beneath a clean cover system and hardstanding to mitigate. Concentrations of SVOCs (2-methylnaphthalene, Dibenzofuran, Carbazole and, Anthraquinone) above the laboratory limit of detection have been identified however given the properties of the SVOCs and associated pathways the risk has been determined to be low and no further works are required.
Controlled Waters Risk Assessment	Elevated concentrations of chromium (VI), zinc, pH, naphthalene and TPH Aromatic C12-C16 have been identified within leachate analysis. Within the groundwater analysis elevated levels of selenium and zinc were identified. The underlying Made Ground is considered to be the source of potential elevated determinants. The site is underlain by cohesive CLAY drift deposits which are of low permeability and will limit lateral and vertical migration of any possible contaminants. The site is not located within influencing distance of any surface water features. Furthermore, the closest abstraction point is located 686m south of the site and utilised for process water. Given the distance from site and presence of low permeability CLAY deposits the risk is considered to be low.
Ground Gas	The site is considered to be classified as Characteristic Situation 2.
Coal Mining and Historical Workings	The site is not considered to be at risk from mining or quarrying-related issues.
Invasive Plants	No invasive plant species were identified during the preliminary site walkover. The remediation contractor should review all ecological reports and undertake their own surveys to confirm the presence of any invasive plant species and the requirement for treatment and eradication as part of their works.
Potable Water Supply	This will need to be confirmed following the completion of a UKWIR risk assessment. Post-remediation and enabling works ground conditions may be different from those identified during this site investigation, however an allowance for barrier pipe should be considered.

GEOTECHNICAL ASSESSMENT

Relict Sub-Structures	A number of concrete and brick obstructions have been encountered within the Made Ground indicative of fill material used to raise levels for the subject site. These were encountered as large boulders of brick and concrete and will require removal during site enabling works in order to prepare the development platform. Additionally, service infrastructure has been identified on site (electricity and site sewage system) which will require diversion for the construction of the development.
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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.
Proposed Structural Foundations	Upon completion of enabling works, the Made Ground is likely to be present at varying depths and as such it is likely that the most cost-effective option for the site would comprise either pad foundations bearing at least 500mm below the stiff to very stiff medium to very high strength cohesive soils at circa 2.00mbgl. or to re-engineer the Made Ground using vibro-stone columns (VSCs) to support a pad foundation at a shallower depth subject to the required loadings. During development, consideration of completing VSC in close proximity to sensitive infrastructure (electricity, gas mains, on-site sewage system) must be taken. Furthermore, consideration of the structural loadings that will induce a bulb of pressure should be taken into account. In the event structural loadings require increased safe ABP, it will be necessary to transfer structural loading to the deeper CLAY drift deposits by a pile foundation. Sporadic trees surround the site periphery and as such their influence will need to be modelled to assess the requirement to deepen foundations (below current elevations) to mitigate the potential for volumetric instability attributed to fluctuations in moisture content in accordance with the requirements of LABC standards.
Building Floor Slabs	A ground-bearing slab will be viable, but it will need to be constructed on a granular sub-base with the thickness designed by a structural engineer to ensure that settlement tolerances are taken into consideration and that sufficient surface clays have been removed from tree influence areas to mitigate any seasonal volume changes in the clay influence zones. Proposed levels and the requirement for ground treatment should be considered at the detailed design stage.
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	This document provides a comprehensive specification for the regeneration of the land in a manner that will negate the identified pollutant and ensure the development is suitable for the proposed end use. The salient features of the Remediation & Enabling Works Strategy are summarised below: ✿ Implementing of all works in strict accordance with UK Environmental Permitting and local planning authority requirements. ✿ Controlled removal of all trees and vegetation. ✿ Removal and treatment of all invasive plant species (as required) in accordance with specialist contractor method statement, validation and independent certification in the event invasive species are identified. ✿ Supplementary site investigation in the vicinity of the former pond and concrete hardstanding in the south of the site previously inaccessible. ✿ Excavation, and removal of all existing above and below ground structures beneath the proposed structural foundation. ✿ Diversion of currently live service infrastructure. ✿ Sorting, processing and segregation all deleterious materials. ✿ Materials deemed unsuitable for retention to be removed from site. ✿ Location, delineation and excavation of former infilled ponds. ✿ Location; isolation and management of any asbestos impacted soils. ✿ Validation sampling to confirm all material retained on-site poses no risk to the identified receptors within the context of the CSM. ✿ Processing of Made Ground to recycle aggregate as Class 6 Material. ✿ Importation of chemically suitable materials (if required) to achieve the required development elevation. ✿ Removal of any previously unidentified contamination hotspots. ✿ Validation testing of materials placement to confirm suitability. ✿ All works to be undertaken in strict accordance with UK Environmental Permitting and Local Planning Authority Requirements.
Geotechnical Engineering Requirements	The nominated earthworks and stabilisation contractor will be responsible for the placement and re-engineering of stiffened soil platform using engineered Class 1 & 2 soils to be capped with a 300mm engineered sub-base and capping system. This performance specification defines the geotechnical compaction requirements for engineered soils and sub-bases to ensure compliance with the project engineering requirements. Preparation of Formation (all areas) – Prior to the placement of any soils, the formation area (reduced level excavation) will be assessed and certified as suitable to ensure that all identifiable soft spots or areas of variable strata have been identified, and engineered with a suitable soil or aggregate that has been compacted in accordance with the Geotechnical Performance Specification.



	In general, all soils (excluding certified recycled and quarried aggregates) must be engineered to achieve the following performance criteria: ✚ Compaction to excess of 95% of the Maximum Dry Density (4.5kg/rammer) or 100% of the MDD (2.5kg/rammer); ✚ Maximum 5% air void ratio in engineered cohesive soils; ✚ CBR in excess of the performance requirements for each and every engineered soil layer; ✚ Maximum deformation under Plate Load using applicable loading for each and every layer must not exceed maximum settlement tolerance within engineered fill and sub-base replacement; ✚ CBR in excess of 15% within engineered sub-base / sub-base replacement beneath the building floor slab (underside of MOT 1); and, ✚ CBR in excess of 15% on engineered soil (sub-base replacement) / sub-base beneath external hardstand. Building Floor Slab – Engineering of a stiffened soil platform to ensure a net safe Allowable Bearing Pressure in excess of 50kN/m² to achieve the settlement requirements of the Structural Engineer which is nominally <25mm total and 10mm differential with a CBR >30% at formation (top of MOT 1). External Hardstand – Engineering of a stiffened soil platform to ensure total settlement of <25mm with differential settlement of <10mm to achieve a CBR of >30% at formation (top of MOT 1).
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BUILD PHASE REQUIREMENTS

Summary of Build-Phase Mitigation Requirements	The developer's works will also include the completion of the following additional elements: ✚ Provision of a 300 mm cover system with break layer using certified material with appropriate validation within proposed areas of public open space and soft landscaping. ✚ Design and installation of CS2 ground gas mitigation measures to be compliant with BS 8485; and, ✚ Construction of appropriate potable water supply infrastructure. Current ground conditions suggest PE Barrier Pipe will be required.
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1. INTRODUCTION

1.1. BACKGROUND

E3P has been instructed by Multimaq Limited (the client) to develop a remediation strategy and enabling earthworks performance specification for the proposed commercial and industrial development for a parcel of land to the south of Bridge Road North, Wrexham, herein referred to as the site.

1.2. SITE DETAILS

The subject site is a roughly rectangular shaped parcel of land located to the south of Bridge Road North, Pacific Park, Wrexham (E338540 N349910) and is approximately 0.62 Ha. Topographically the site is generally flat.

The majority of the site is utilised as haulage parking for the UnimaQ building to the south of the site. The site is predominantly covered in a loose hardstanding material with no structures present.

The southern tip of the site is used as the staff carpark for UnimaQ. Across the site there are several rubble stockpiles, with overgrown vegetation, and there are various materials, such as steel girders, stored at the site.

The site is bound an area of commercial / light industrial units and bound to the west by Bridge Road North, south west by Unimaq with mature trees forming the boundary to the north and east of the site with commercial beyond.

Medium and intermediate pressure gas pipelines runs across the west of the site, orientated north to south. A gas enclosure is present along the western boundary of the site.

1.3. REPORT OBJECTIVES

The objectives of this report are to:

-  Prepare 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 a site remediation and enabling works plan;
-  Specify geotechnical engineering performance requirements; and
-  Ensure the safe, cost effective and regulatory compliant redevelopment of the site.



1.4. 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.

1.5. PREVIOUS WORKS

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

- ✳ **E3P** – *Phase I Geo-Environmental Site Assessment*. Ref: Report No. 14-255-R1-1, dated July 2020, Prepared for Portal Construction N.W. Ltd.
- ✳ **E3P** – *Phase II Geo-Environmental Site Assessment*. Ref: Report No. 14-255-R2-1, dated May 2021, Prepared for Multimaq Limited.
- ✳ **E3P** – *Ground Gas Addendum Report*. Ref: Report No 14-255-R3-1, dated July 2021, Prepared for Multimaq Limited.

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

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

1.6. REDEVELOPMENT PLAN

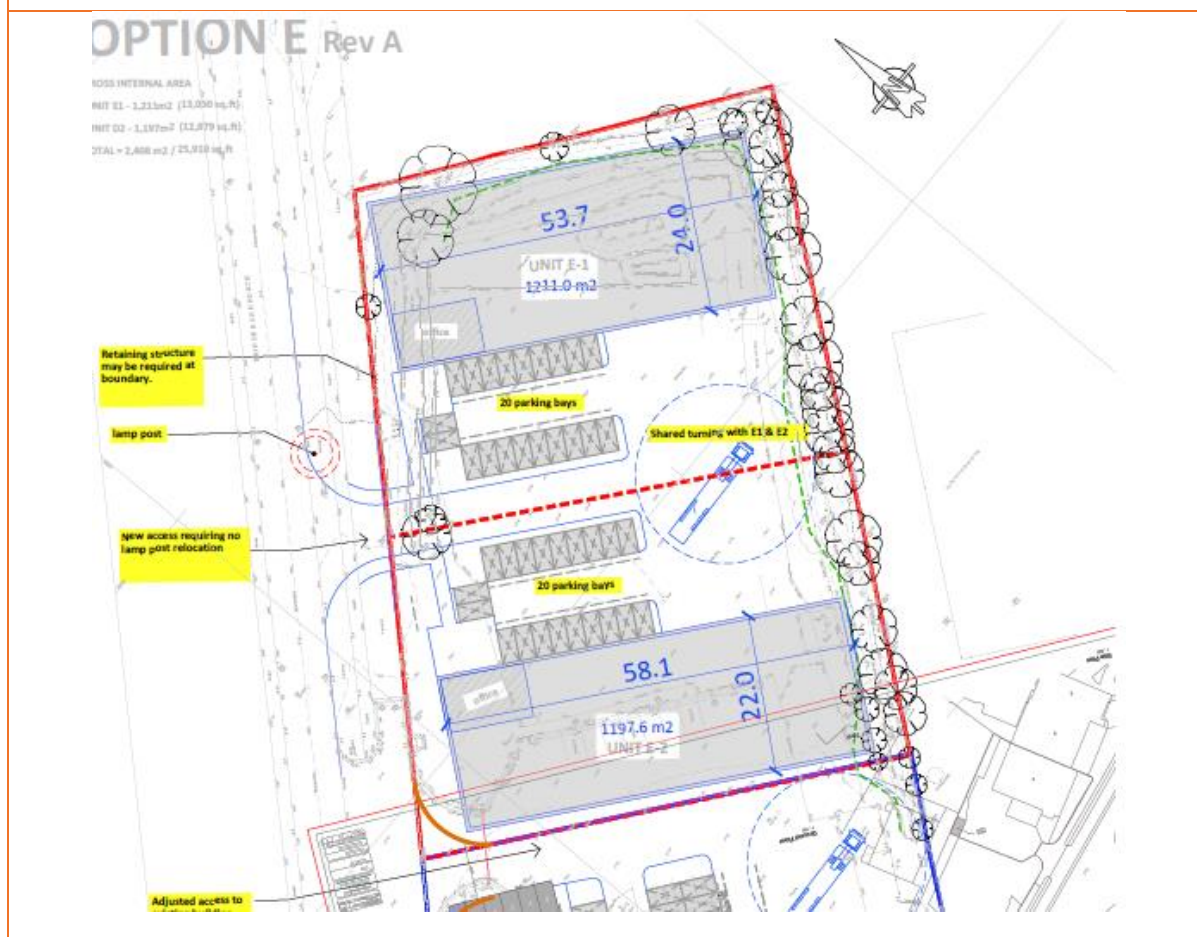
E3P understands that the proposed development will comprise of two industrial units with associated adopted estate roads and utility infrastructure.

Drawing 14-255-002 (Appendix III) identifies the proposed development layout.

A snapshot of the proposed development layout is indicated in Figure 1.1.



FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.7. SUMMARY OF PARTIES INVOLVED

Function/interest	Name of Party
Local Planning Authority	Wrexham County Borough Council
Developer	Multimaq Limited
Geoenvironmental Consultant	E3P
Main Contractor	TBC
Remediation/Enabling Works Contractor	TBC
Human Health Regulator	Wrexham County Borough Council
Highways Adoption Authority	Wrexham County Borough Council

1.8. REGULATORY CORRESPONDENCE

Multimaq Limited have recently received planning permission from the local planning authority for the proposed redevelopment of the site for a commercial / industrial development with associated adopted estate roads and infrastructure.

As part of the planning approval process, the planning authority has undertaken consultation with the pertinent statutory consultees, which will include:



- ✳ Environmental health/contaminated land officer at the local authority (or external adviser); and,
- ✳ National Resources Wales.

E3P have been provided with comments from the Environmental Health Officer on the review of the Phase 2 Geoenvironmental Assessment and the queries have been covered within this report. The Remediation Strategy will require review and acceptance from the Environmental Health Officer.

National Resources Wales have been consulted and they consider that the controlled waters on this site are not of the highest environmental sensitivity and therefore have no objection to the condition in relation to contaminated land being discharged.

1.9. SITE DETAILS

Site Address	Land south of Bridge Road North, Pacific Park, Wrexham, LL13 9PN
National Grid Reference	E338540 N349910
Site Area	0.62 Hectares

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 14-255-001.

1.10. SITE SUMMARY

TABLE 1.1 SITE DESCRIPTION AND SETTING

Occupancy/Use	The majority of the site is utilised as haulage parking for the Unimaq building to the south west.	
	The southern tip of the site is used as the staff carpark for Unimaq. Across the site there are several rubble stockpiles, with overgrown vegetation, and there are various materials, such as steel girders, stored at the site.	
	The site is bound an area of commercial / light industrial units and bound to the west by Bridge Road North, south west by Unimaq with mature trees forming the boundary to the north and east of the site with commercial beyond.	
	Medium and intermediate pressure gas pipelines runs across the west of the site, orientated north to south. A gas enclosure is present along the western boundary of the site.	
Environmental Setting	Drift Geology	Till (Devensian – CLAY) across the site.
	Bedrock Geology	Salop Formation – Mudstone, Sandstone and Conglomerate.
	Hydrogeology	Secondary Undifferentiated aquifer strata overlying a Secondary A Aquifer (Bedrock Geology).
	Hydrology	There is a small surface stream located 86m to the east of the site.
	Flood Risk	The site is located within Flood Risk Zone A and is considered to be at little or no risk of river flooding.
	Subsidence Hazard	No hazard identified in data searches.



Site History	Historical mapping suggests that the site was undeveloped agricultural land until the 1950's when the land was redeveloped as part of a wider industrial park. Circa 1961 the site had a series of railway lines bisecting the central and eastern areas. By the 1970's the railway lines were no longer present, and the land was left vacant. Circa 1989 the land was cleared and a pond appears to be present in the south-west of the site. Circa 2003 the pond was no longer present and the site is being used as a haulage storage yard for HGV trailers and remains in the same configuration until present day. A review of the plans and desk study provided by the EHO appear to show that the subject site was in the wider area of works associated with ROF Wrexham, but no historical buildings have been identified on the subject site which may be associated with the manufacture of explosives. The railway associated with ROF Wrexham is present on-site. Various works within the wider area are noted on historical plans which are likely to have been associated with ROF Wrexham.
Landfill Sites and Ground Gases	The Envirocheck report indicates that no historic landfills are present within 250 m of the site. A current landfill entry is present 52 m south of the site, however the site is closed. There are a number of waste treatment sites within 250 m of the site. It was confirmed from the EHO that a former PCB landfill cell is adjacent to the southern corner of the site.
Radon	Unaffected – no special precautions required.



1.11. SUMMARY OF REPORTED GROUND CONDITIONS

E3P has prepared a detailed Site Investigation Report (Ref: 14-255-R2-1, dated July 2021). The summary of reported ground conditions is given in Table 1.2.

TABLE 1.2 SUMMARY OF GROUND CONDITIONS

Made Ground	Made Ground deposits were encountered within all exploratory hole locations to depths of between 0.21m and 2.10m bgl (TP106), however, generally Made Ground was encountered to a depth of less than 1.60m bgl. Made Ground Within TP101 a layer of black reworked clay (0.09-0.20m bgl) was observed overlying a layer of limestone gravel. The trial pit was terminated due to the likely presence of underlying services. Made Ground deposits comprise a grey sandy gravel of concrete, limestone and asphalt overlying the majority of the site with the exception of TP103 where the location was overlain with a grey slightly silty, sandy gravel of limestone. Underlying the above strata varying Made Ground deposits were encountered including localised areas of a black sandy gravel of concrete and brick was encountered to depths of 0.61-0.70m bgl. Within a number of locations across the site a reddish brown sandy gravel was encountered with gravel of brick, metal wire and plastic with large boulders of concrete and sections of brick wall encountered at depths of between 0.14-1.21m bgl. Made Ground has also been noted to comprise a stiff blackish brown sandy gravelly clay was observed. Within centre and northern areas a brownish black sandy gravel with pockets of clay was encountered where the gravel consisted of ash, clinker and mudstone likely to be associated with the former railway tracks.
Drift	Drift deposits were encountered within the majority of exploratory location with the exception of TP101 where the full depth of Made Ground could not be proven due to potential underlying services. The drift deposits generally comprised a stiff to very stiff, high to very high strength brown slightly gravelly CLAY with gravel of sandstone and quartz. CLAY deposits were interbedded with a brown slightly clayey medium SAND within CP101 at a depth of 15.70-15.90m bgl and in CP102 at depths of between 21.20-21.40m bgl.
Bedrock	Solid geology was not encountered during the ground investigation. A review of BGS borehole records in the vicinity of the site have not encountered the underlying bedrock geology, and it is assumed to be in excess of 30.00mbgl.
Groundwater	Groundwater strikes were encountered as strikes, seepages and perched water between 0.60m and 21.20mbgl. True groundwater is considered to be between 15.70m and 21.20mbgl within SAND bands within the CLAY drift deposits.



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 environ. 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. LIMITATIONS OF THE INVESTIGATION

The following limitations were encountered during the ground investigation:

- ✚ Intermediate and high-pressure gas mains as well as a gas box are present within the adjacent road and along the north western boundary of the site, requiring a 15m easement on works. Furthermore, electricity infrastructure is present along the north western boundary of the site which impeded exploratory work in this area in which the former pond is located.
- ✚ Drainage infrastructure is present in the south of the site linking the current building on the wider site to an on-site sewage system tank in the east of the site.
- ✚ Works could not be completed on the area of concrete hardstanding in the south of the site as it is currently utilised by the operational building in the wider site, south of the proposed development, for car parking.

2.3. 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;
- ✚ Benzo(b)Fluoranthene;
- ✚ Benzo(a)Pyrene; and,
- ✚ Dibenzo(a,h)Anthracene.

In addition to the above the following SVOCs have been detected above the laboratory limit of detection (LOD) within WS106 at 0.50m, where a hydrocarbon odour was noted during the site investigation:

- ✚ 2-methylnaphthalene;
- ✚ Dibenzofuran;
- ✚ Carbazole; and,
- ✚ Anthraquinone.



Made Ground deposits in WS101 were tested for PCBs due to the proximity to the former PCB landfill area bordering the south eastern sector of the site. PCBs were tested for within WS101 at 0.72m within Made Ground deposits and at 1.00m within underlying CLAY drift deposits. PCBs were detected in both samples above the LOD with total PCBs within WS101 at 0.72m equating to 0.25 mg/kg and 0.70 mg/kg.

Asbestos in the form of loose chrysotile fibres has been identified in the granular and cohesive Made Ground within WS101 (0.65m and 0.72m), WS104 (0.60m), TP108 (0.40m), and TP110 (0.60m). Amosite loose fibres have been identified within TP102 (0.60m).

In relation to these exceedances, the following can be determined:

- ✚ The main exposure pathways based on the Tier I exceedances are:
 - Soil ingestion;
 - Dermal contact and ingestion;
 - Vapour Inhalation; and,
 - Fibre/dust inhalation.
- ✚ The exceedances for all determinants are associated with shallow Made Ground deposits and isolated CLAY drift deposits.

HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

All of the identified elevated concentrations have primary exposure pathways related to dermal contact and ingestion of soils, inhalation of particulate and vapour inhalation. The risk to chronic human health associated with the elevated concentrations of non-volatile PAH compounds and PCBs can be mitigated through the installation of a suitable cover system in all, landscaping and public open space to remove any potential for direct exposure to impacted soils or for the commercial premises covered by suitable hardstanding. A no dig barrier is recommended beneath a cover system due to the presence of PCBs.

Industry best practice (as outlined within BRE 465) will require the following minimum depths of certified clean cover:

- ✚ Landscaped areas – **300 mm with no dig barrier.**

SVOCs 2-Methylnaphthalene, Dibenzofuran, Carbazole and Anthraquinone above the laboratory LOD have been identified within WS106 at 0.50m within Made Ground deposits and present a potential volatilisation to indoor air risk. A risk assessment was completed within the Phase II Geoenvironmental Assessment which determined them highly unlikely to pose a risk in terms of vapour migration and ingress to the proposed development and as such no further works are considered necessary.

PCBs above the LOD have been detected within Made Ground and CLAY soils in WS101. PCBs were tested for within WS101 at 0.72m within Made Ground deposits and at 1.00m within underlying CLAY drift deposits. PCBs were detected in both samples above the LOD with total PCBs within WS101 at 0.72m equating to 0.25 mg/kg and 0.70 mg/kg. The US EPA determines a threshold of 49 mg/kg for industrial soil for PCB 118. Concentrations identified within both Made Ground and CLAY deposits do not exceed this and therefore not considered a risk to future end users.

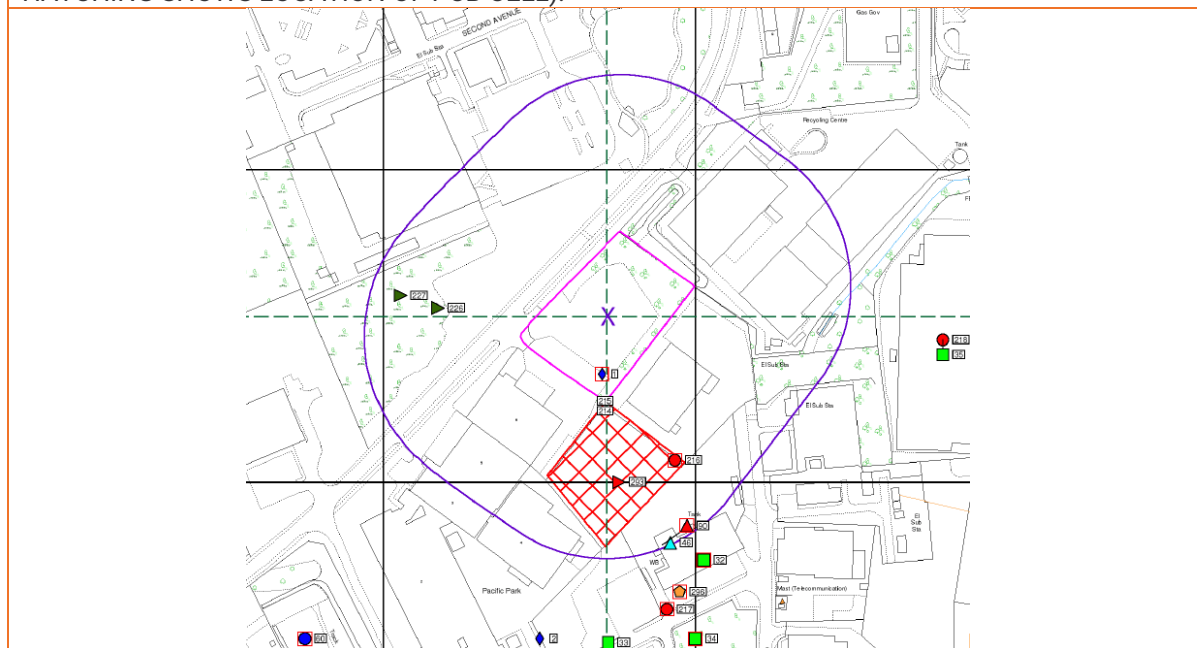


Within the E3P Phase 2 Geoenvironmental Site Assessment for the subject site (Report Ref:14-255-R2-1, dated May 2021) it was recommended that a hotspot removal should be undertaken in the vicinity of WS101. However, E3P have received comments from Wrexham Borough Council following the review of the Phase 2 report, which have provided further information in regards to PCBs at the subject site which are summarised below:

- ✚ “The PCB contamination on the industrial estate is due to a historic former capacitor factory which is understood to have caused widespread PCB contamination. The area was remediated in 1987 in regard to the PCB impacted soils:
- ✚ Heavily contaminated soils (PCB concentration >10,000 mg/kg) were sent off site for incineration.
- ✚ Less contaminated soils (PCB concentration >20 mg/kg to <10,000 mg/kg) were moved into the purpose built PCB containment cell.
- ✚ Soils with a PCB concentration of <7.2 mg/kg were deemed to be safe to leave on site.
- ✚ A site known as Georgia Pacific, in close proximity to the development site, has since undergone further assessment and remediation for development purposes. As part of these works a site specific assessment criteria was derived for PCB Aroclor 1254 of 7.2 mg/kg by BAE Systems in 2006 and accepted by the Council.”

Figure 2.1 provides a snapshot the location of the PCB containment cell in relation to the subject site from the Envirocheck Report.

Figure 2.1 – LOCATION OF PCB CONTAINMENT CELL IN RELATION TO SUBJECT SITE (RED HATCHING SHOWS LOCATION OF PCB CELL).



The PCB cell is located off-site however is close to the site boundary. Any works in along the boundary should take into consideration of the PCB cell with no soils disturbed in the area.



In accordance with the Agency for Toxic Substances and Disease Registry (<https://www.atsdr.cdc.gov/toxprofiles/tp17-c4.pdf>, accessed 12th July 2021) Aroclor 1254 is a mixture of PCB compounds including those tested for and identified as part of the E3P site investigation (PCB Congener 28, PCB Congener 52, PCB Congener 101, PCB Congener 118, PCB Congener 138, PCB Congener 153 and PCB Congener 180). As such this compound is deemed a suitable marker to complete further assessment of the PCBs on site.

Aroclor 1254 is a light-yellow viscous liquid or soil (below 10°C) with a mild hydrocarbon odour. The US EPA Regional Screening Levels for Aroclor 1254 and industrial soil is 0.97 mg/kg. Additionally, Pub Chem has highlighted that in relation to inhalation risks, a harmful contamination of the air will be reached rather slowly on evaporation of Aroclor 1254 at 20°C. Soils at the subject site are unlikely to reach this temperature and therefore there is not considered to be a risk of the PCBs identified becoming volatile.

Concentrations of PCBs identified to date do not exceed the US EPA screening level and therefore there is not considered to be any further risk to the end user in relation to the concentrations identified to date on site.

It can be anticipated that a greater extent of PCB contamination is present on the subject site given the site is part of a wider area which has undergone remediation works; it is likely that concentrations above the US EPA screening level will be identified, as works in the 1980s allowed PCBs to remain on site if concentrations were <20 mg/kg. The more recent remedial works undertaken at the industrial estate developed a SSAC of 7.2 mg/kg for PCB Aroclor 1254.

Due to this it can be deemed appropriate that the use of a clean cover system in areas of soft landscaping can suitable mitigation in relation to contaminant pathways of dermal contact and ingestion; whilst areas beneath the future building footprint will have an adequate cover system in the form of concrete hardstanding.

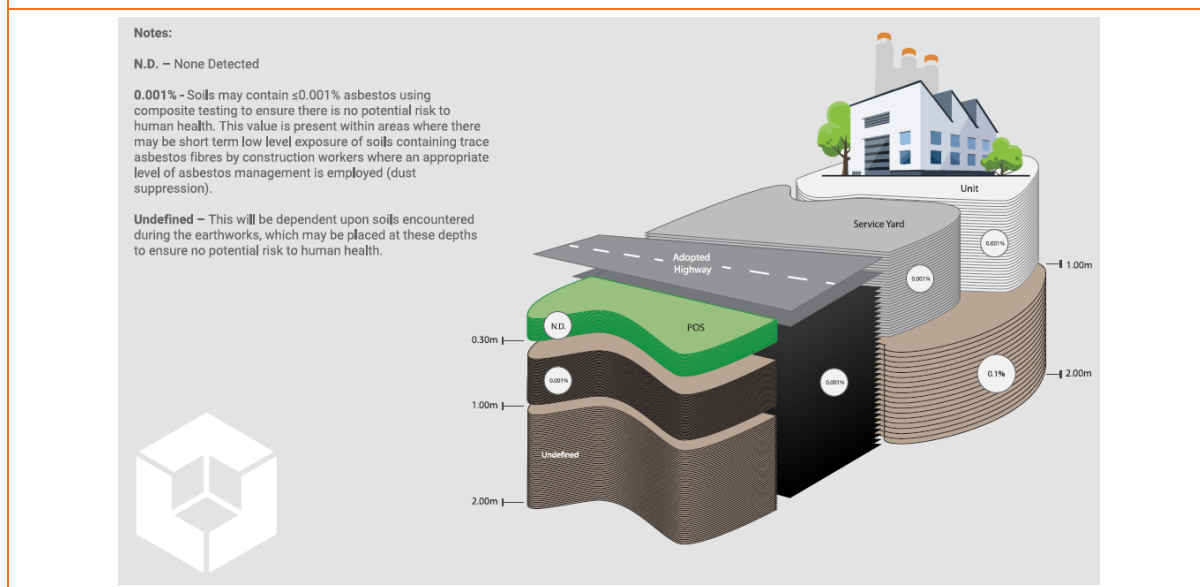
For the purposes of the remediation validation, a threshold of 7.2 mg/kg will be utilised for soils across the site as this has been utilised for adjacent developments.

Asbestos in the form of chrysotile and amosite has also been identified within localised areas in shallow Made Ground deposits. Asbestos quantification has been completed with concentrations between <0.001% and 0.002%. No visual signs of ACM were encountered during the ground investigation; it is therefore likely that only trace fibres are present. It is likely that trace fibres are present within all Made Ground deposits on site. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 2.2.

Asbestos has been identified in WS101 and TP108 at a concentration of 0.002%. These areas should therefore be isolated and undergo a phase of delineation and hotspot removal with placement within an area of low sensitivity in line with the asbestos risk mitigation conceptual site model.



FIGURE 2.2 ASBESTOS RISK MITIGATION CONCEPTUAL SITE MODEL



Notes

ND None Detect

0.001% Soils may contain $\leq 0.001\%$ 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 $>1.00\text{m}$ 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 landscaping areas with the exception of CLAY soils within WS101 where PCBs have been identified; however, further chemical validation samples will be required to confirm this. There are no suitable sources of topsoil available on the site.



2.4. CONTROLLED WATERS CONTAMINATION RISK SUMMARY

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

-  Chromium (VI)
-  Selenium
-  Zinc
-  pH
-  Naphthalene
-  TPH C12-C16

PCBs were tested for within all groundwater samples however no concentrations above the LOD were detected.

Concentrations above EQS screening values have been identified however due to the absence of any surface water features within 50m of the subject site there is not considered to be a complete pollutant linkage and as such there is not considered a risk to surface water features.

In relation to the elevated chromium (VI), zinc, pH, naphthalene and TPH Aromatic C12-C16 these are associated with isolated occurrences from leachate analysis undertaken in Made Ground soils. Where leachate analysis has been undertaken, this can overstate the risk and is not wholly representative of the site characterisation. Following the completion of groundwater analysis, elevated concentrations of chromium (VI), pH, naphthalene were not identified.

Within the groundwater analysis elevated levels of selenium and zinc were identified.

Historically, the site has been subject to infilling and a number of industrial uses including railway lines crossing the site and subsequently a haulage yard in its current day use. The underlying Made Ground is considered to be the source of potential elevated determinants.

The site is underlain by cohesive CLAY drift deposits which are of low permeability and will limit lateral and vertical migration of any possible contaminants.

The site is not located within influencing distance of any surface water features. Furthermore, the closest abstraction point is located 686m south of the site and utilised for process water. Given the distance from site and presence of low permeability CLAY deposits the risk is considered to be low.

PCBs were identified within the soil analysis on site however they have not been detected within the groundwater analysis completed, and therefore are not considered to be mobile

2.5. GROUND GAS

2.5.1. GAS ASSESSMENT

In accordance with the methodology outlined with the CIRIA publication C665, E3P have utilised the results of the ground gas monitoring surveys to calculate a tentative gas screening value (GSV). The GSVs for the monitoring positions are summarised in Table 2.1.



TABLE 2.1 GAS RISK PROFILE AND LOCATION

LOCATION	MAX CO ₂ (% v/v)	GSV (l/hr)	MAX CH ₄ (% v/v)	GSV (l/hr)	CLASSIFICATION
WS106	1.30	-0.01872	0.10	-0.00144	CS1

The GSV has been compared to the criteria outlined with CIRIA C665 to determine the level of risk to the proposed development and to ensure the appropriate remedial options are incorporated into any future building design in this area.

Limited ground gas monitoring suggests that the site can be classified as CS1 from factual data, however, given there are a number of potential gas sources on site or in close proximity (Made Ground, infilled pond and off-site landfill cell), and the assessment has only been completed off one borehole as the remaining boreholes were flooded, an allowance of CS2 should be considered.

As such, E3P have completed an RB17 assessment using TOC (Total Organic Carbon) results taken from chemical analysis of soil samples during the ground investigation to further refine the ground gas assessment.

Following the completion of the ground gas monitoring and subsequent RB17 assessment it is determined that the site should be classified as Characteristic Situation 2 and ground gas protection measures are required in the construction of the proposed development. The full assessment is summarised within the E3P Ground Gas Addendum Report (Report Ref: 14-255-R3-1, dated July 2021).

Given the site is underlain with Made Ground in excess of 1.00m, and on and off-site infilled features have been identified, there is considered to be significant sources which have the potential to produce hazardous ground gases. Therefore, the proposed development will require specialist protection measures in accordance with Characteristic Situation 2.

2.6. POTABLE WATER SUPPLY INFRASTRUCTURE

A contaminant risk assessment completed in accordance with the UKWIR assessment framework will be required in order to identify elevated concentrations of potentially volatile/soluble hydrocarbon compounds. 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.

Analysis of soils at to date have identified concentrations of determinants above the PE threshold. It is likely that during the enabling works materials may be utilised in different areas of the site. Site conditions are likely to vary to current conditions following remediation and enabling works. As such, it is likely that barrier pipe will be required at the proposed development; confirmatory sampling will be required along the pipeline route following remediation and enabling works.



3. SITE REMEDIATION AND ENABLING WORKS

3.1. REMEDIATION OPTIONS APPRAISAL

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

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

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

3.2. DETERMINATION OF SUFFICIENCY OF INFORMATION

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

Intrusive ground investigation works completed to date is considered acceptable to fully understand the risks to future end users, controlled waters and the wider environment.

The only area where the full understanding of potential risks has not been completed, is the area of possible infilled land associated with the former pond and an area of hard standing in the south currently utilised for car parking. Works to investigate these areas is recommended as part of the remediation and enabling works, with results reported to the Local Authority when available.

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 Made Ground deposits and the PCB cell located off site.

3.3. REQUIREMENT FOR REGULATORY CONTROL

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

- ✿ Requirement for regulatory permits.

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

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

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



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

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

3.4. CONTAMINANTS OF CONCERN (COC)

3.4.1. NON-VOLATILE PAH COMPOUNDS

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

- ✿ Direct contact with the soil source by future on-site users; and,
- ✿ Ingestion of impacted soils by future on-site users.

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 in the form of chrysotile and amosite has also been identified within localised areas in shallow Made Ground deposits. Asbestos quantification has been completed with concentrations between <0.001% and 0.002%. No visual signs of ACM were encountered during the ground investigation; it is therefore likely that only trace fibres are present. It is likely that trace fibres are present within all Made Ground deposits on site.

Asbestos has been identified in WS101 and TP108 at a concentration of 0.002%. These areas should therefore be isolated and undergo a phase of delineation and hotspot removal with placement within an area of low sensitivity in line with the asbestos risk mitigation conceptual site model.

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.

All ACM-impacted soils must be managed so as to ensure no airborne fibre release during construction or placement of impacted material in such a manner as to ensure no future exposure risk.

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 at a suitably licensed facility.

3.4.3. PCB'S

PCB's have been identified at concentrations within WS101 at 0.72m equating to 0.25mg/kg and 1.00m equating to 0.70mg/kg.

A suitable clean cover system and hardstanding is considered suitable mitigation for the PCBs identified on-site.

Given the likely presence of PCBs across the site, a threshold value of 7.2 mg/kg will be utilised with additional testing of bulk fill materials completed as part of the validation testing throughout the remediation and enabling works.

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

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

3.5.2. AVAILABLE TECHNOLOGIES

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



TABLE 3.1 SOIL REMEDIATION TECHNOLOGIES

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

3.5.3. SELECTION OF TECHNOLOGY OPTIONS

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

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



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

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

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



TABLE 3.2 ASSESSMENT OF REMEDIATION TECHNOLOGIES APPLICABILITY

REMEDIAL TECHNOLOGY	APPLICABILITY	REGULATORY APPROVAL / PERMITRY	COST	TIME-FRAME	SCORE	SUITABILITY COMMENT
Capping	5	5	5	5	20	Essential remediation solution to remove direct exposure pathways if any materials impacted with asbestos, PAHs or PCBs are to remain on site. Capping required in areas of Made Ground.
Electro-remediation	0	0	0	0	0	Not Applicable.
Soil washing	0	0	0	0	0	Not Applicable.
Soil vapour extraction	0	0	0	0	0	Not Applicable.
Ex-situ bio-remediation	0	0	0	0	0	Not Applicable.
Thermal desorption	0	0	0	0	0	Not Applicable.
Vitrification	0	0	0	0	0	Not Applicable.
Stabilisation / Solidification	0	0	0	0	0	Not Applicable.
Remedial Technology	0	0	0	0	0	Not Applicable.
Excavation and offsite disposal	3	3	4	3	13	Asbestos impacted materials with quantification of 0.002% should be able to remain on site in line with the E3P Asbestos Conceptual site Model. Should there be an excess of materials then the materials may require off-site disposal. Additionally following information provided by the EHO, Made Ground materials across the site are likely to contain PCBs. Materials with PCBs greater than 7.2 mg/kg will require removal and placement in an area of low sensitivity or disposed off-site.
Enhanced Bioremediation	0	0	0	0	0	Not Applicable.



REMEDIAL TECHNOLOGY	APPLICABILITY	REGULATORY APPROVAL / PERMITRY	COST	TIME-FRAME	SCORE	SUITABILITY COMMENT
Monitored Natural Attenuation	0	0	0	0	0	Not Applicable.
Vacuum Enhanced Recovery	0	0	0	0	0	Not Applicable.
Air sparging / Bio-sparging	0	0	0	0	0	Not Applicable.
In situ oxidation	0	0	0	0	0	Not Applicable.



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 for the site:

- ✚ Construction of capping system in areas of Made Ground to reduce mobility of any potential soluble phase impact and ensure no direct exposure pathway to future receptors.
- ✚ PCBs identified above 7.2 mg/kg will require excavation and placement in an area of low sensitivity or removed from site. Any materials remaining on site with PCB impacted soils will require placement beneath a certified clean cover system or hardstanding to ensure no risk to future end users.
- ✚ Offsite removal of asbestos impacted materials not required to remain on site.

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 Supplementary Site Investigation

The area of the concrete slab in the south of the subject site was not investigated due to its use as car parking for the adjacent industrial property. Additionally, investigation of the former infilled pond was restricted due to the presence of gas infrastructure and underlying services.

Further investigation will be required within these areas to determine ground conditions and confirm no unidentified contamination. Results of the supplementary site investigation will be submitted to the planning department.

RE-2 – Pre-commencement Regulatory Compliance

Prior to 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 Waste Exemptions should be registered with the EA.

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

If the proposed volume of soils to be reused (excluding crushed materials) exceeds the parameters of the Waste Exemption, 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.



RE-3 – Service Infrastructure

A review of utility plans have identified electricity infrastructure on-site which will require diversion as part of the proposed development.

The site contains a sewage treatment system tank and pipe work which will require diversion in the construction of the proposed development.

RE-4 – Unexploded Ordnance

The subject site was in the wider area of works associated with ROF Wrexham, but no historical buildings have been identified on the subject site which may be associated with the manufacture of explosives.

The requirement for UXO clearance during the remediation and construction works should be considered by the contractor.

RE-5 – Environmental 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 with the local authority and implemented on site.

RE-6 – Risk to Infrastructure

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

Medium pressure and intermediate pressure gas mains are present within Bridge Road North along the western boundary of the site, with a gas governor box present in the south-west of the subject site. 15m easements will be required in relation to the gas infrastructure with confirmation from the utility provider if works will encroach within the 15m easement.

Any works completed on the south and eastern boundaries should take into consideration the location of the adjacent PCB cell and ensure there is no disturbance of soils in this area.



RE-7 – Identification, Isolation and Treatment of Invasive Plants

No invasive species have been identified on site during works completed by E3P.

The remediation contractor must satisfy themselves with respect to the extent of all species deemed invasive 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-8 – Site Clearance Operations

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

The site boundaries contain overgrown self-seeded vegetation and semi-mature trees, with areas of stockpiled materials. Materials 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 site in accordance with waste permitting regulations.

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

RE-9 – Delineation, Excavation and Treatment of Identified Asbestos Impact

Detectable asbestos fibres have been identified in discreet locations; 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 management of soils to negate any future risk. It is recommended that a hotspot removal of Made Ground materials within WS101 at 0.65m and TP108 and 0.40m where 0.002% asbestos has been identified. Upon completion of the delineation and excavation, the sides and base of the resulting void(s) where impacted material is present will be chemically validated to confirm that no impacted materials remain in situ. The resulting excavated arisings should be placed in line with the E3P Asbestos Conceptual Site Model in an area of low sensitivity.

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 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.

RE-10 – 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 development, 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 6 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 (northern sector), 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-11 – Delineation, Excavation and Treatment of Infilled Historical Pond

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

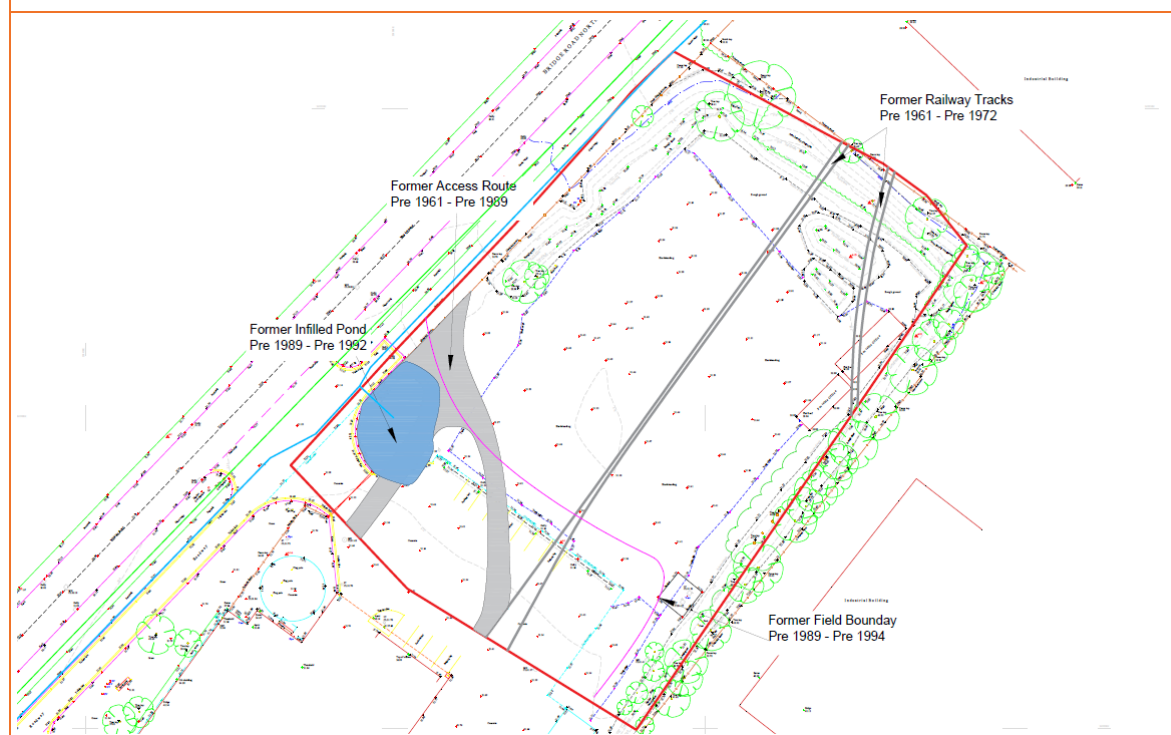
The location of known historic infilled ponds are identified within the E3P Historical Features Plan (Drawing 14-255-003 in Appendix III) and a snapshot is provided within Figure 3.3.

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 3.3 LOCATION OF FORMER INFILLED POND



RE-12 – Removal of Deleterious Material

All potentially deleterious materials will be delineated, stockpiled and removed from site by the contractor to a licensed waste facility.

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). As such it is likely that the most cost-effective option for the site would comprise either pad foundations bearing at least 500mm below the stiff to very stiff medium to very high strength cohesive soils at circa 2.00mbgl. or to re-engineer the Made Ground using vibro-stone columns (VSCs) to support a pad foundation. Relatively shallow competent stratum has been encountered on site however should a uniform 125 kN/m² be required VSC will reduce settlement and increase the ABP for shallow pad foundations to be cast in engineered Made Ground.

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/m².

Where the proposed enabling works levels require the current landform to be cut, extreme care should be taken so as not to disturb the underlying stratum prior to the placement of the appropriate platform, in compliance with the E3P Geotechnical Specification.

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



The maximum dry density must be determined in laboratory conditions utilising UKAS-accredited testing 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 – 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 6 of this report, which generally requires the reinstatement and compaction criteria presented in Table 6.3.

The E3P site investigation has suggested that the most cost-effective foundation option for the site would comprise either pad foundations bearing at least 500mm below the stiff to very stiff medium to very high strength cohesive soils at circa 2.00mbgl. or to re-engineer the Made Ground using vibro-stone columns (VSCs) to support a pad foundation at a shallower depth subject to the required loadings.

During development, consideration of completing VSC in close proximity to sensitive infrastructure (electricity, gas mains, on-site sewage system) must be taken. Furthermore, consideration of the structural loadings that will induce a bulb of pressure should be taken into account.

In the event structural loadings require increased safe ABP, it will be necessary to transfer structural loading to the deeper CLAY drift deposits by a pile foundation.

RE-15 – 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 6).

Imported material must be certified as suitable for use in strict accordance with the E3P chemical and geotechnical performance criteria (See Section 6) 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-16 – 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-17 – 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 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.

Copies of all waste transfer notes will be included within the validation report for the site.

The preferred alternative approach would be to locate a site in the locality that requires soils to achieve required development levels. 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-18 – Validation of Materials for Potable Water Supply Infrastructure

A contaminant risk assessment, completed in accordance with the UKWIR assessment framework should be completed following remediation and enabling works.

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.

The site has been identified as requiring PE Barrier pipework at this stage due to the presence of SVOCs.



RE-19 – 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 site to facilitate the proposed 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 IV), 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 3.3.



TABLE 3.3 SPECIFICATION OF CHEMICAL VALIDATION LABORATORY ANALYSIS

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

Notes

Suites of Analysis:

- A. Speciated PAH.
- B. Speciated TPH (C5-C35).
- C. Asbestos (ID).
- D. CLEA Inorganic Heavy Metals.
- E. Speciated PAH, Banded TPH and VOCs.
- F. SVOC/Speciated TPH.
- G. On-Site Screening for VOC Using Calibrated PID.
- H. Leachate 2:1 Speciated PAH and Banded TPH.
- I. Leachate Analysis of Inorganic Heavy Metals, TPH, Sulphate and PAH.
- J. PCB Analysis

All analysis prescribed above 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 material is to be imported utilising the CL:AIRE DoW CoP from an alternative development site, then only chemically certified, clean, naturally occurring material can be transferred.

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

The importation of material for use within the proposed construction of a development platform will be subject to the compliance with the E3P protocol for the importation of materials as set out within the specification for material import included within Appendix V 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 overarching philosophy of the site enabling works will be the delivery of the following:

- ✿ The final foundation solution is currently pending however it is considered that the site will be prepared to facilitate either the use of a pad foundation or re-engineer the Made Ground using VSC to support a pad foundation.
- ✿ Where Class 1 & 2 materials are using in the cut / fill earthworks, stabilisation agents such as lime may be required to control the moisture content and ensure compaction as engineered structural fill;
- ✿ All hard materials will be processed as a Class 6 recycled material for subsequent compaction;
- ✿ The development platform to the building footprint (+2.0m on all elevations) will be set at the required level below FFL. It is considered likely that the sub-base to floor slabs and external reinforced hardstanding will be constructed using recycled Class 6 material.

The contractor should employ a suitably experienced engineer to be present on site during 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 fine grained soils as a moisture content fluctuation (3% +/-) of the tolerable limit will result in unacceptable degree of compaction loss without appropriate modification and stabilisation. The contractor will be responsible for extensive control testing to demonstrate that the optimum moisture content for all engineering material is within the pre-defined control limits.

Where relict structures / infrastructure has been removed, the reduced level excavation should be formed in a manner where the sides are graded at no greater than a 45o angle that will facilitate the resulting backfilling of the excavation with Class 1 / 2 or 6 soils that are to be engineered to achieve the required performance specification.

The contractor will be responsible for proof rolling and where necessary Ground Improvement in the sub-stratum to ensure it is compacted with all potential variable stratum or soft spots to be removed and replaced with material that is engineered in accordance with the requirements of this specification.

The contractor will undertake to provide a detailed survey of all reduced level excavations with survey positions of a maximum 25m grid increasing to 5m centres where a change in topography greater than 500mm occurs at any one point. The reduced level survey is to be provided to the supervising engineer for review and approval prior to the backfill of the excavation and placement of structural fill material.

In general, all soils (excluding certified recycled and quarried aggregates) must be engineered to achieve the following performance criteria:



- ✳ Moisture content to be within 2% (+/-) of the defined optimum / control value;
- ✳ CBR to meet the required performance spec for the relevant stratum in each and every engineered soil layer; and,
- ✳ Maximum deformation under Plate Load to meet the geotechnical specification within each and every compacted layer.

6.2. LOCALLY-WON FILL MATERIAL

Should the site require upfilling, from the site-specific investigations undertaken to date, it is expected that the majority of the soils will be won from the processing of underlying Made Ground materials which 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% ($\pm$) of the optimum for the soil matrices as determined by laboratory bench testing.

6.3. CLASSIFICATION OF FILL MATERIAL

This specification should be read in conjunction with the following:

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

6.3.1. GENERAL CLASSIFICATION

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

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

Materials can be engineered in accordance with the Methods for General Cohesive Fill (Class 1 or 2) however it is essential the performance criteria of a Class 7A Material is achieved.



6.3.2. USE OF FILL MATERIAL

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 150mm 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.

Prior to the additional of any stabilising agents, laboratory bench testing will be undertaken in accordance with the method and rationale as outlined within the DMRB HA74/07.

For any stabilisation works certain limiting factors must be considered by the contractor in their design:

- ☛ Soils can only be stabilised through the addition of lime/OPC when the ambient air temperature is >7 degrees; and,
- ☛ Ground temperatures cannot fall below 3 degrees.

In addition to any grading requirement for a material type 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 150mm shall not be deposited within the restored surface level unless directed otherwise by the Engineer.

Prior to the commencement of any works, the following laboratory tests are to be completed by the contractor to demonstrate suitability of materials for use as a structural fill and where required to provide bench testing to confirm the applicability of stabilisation agents.

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 requirements, stabilising agents should be added to assess suitability for use to the contractors own design.

6.4. GENERAL PERFORMANCE REQUIREMENTS – ENGINEERED FILL

The contractor shall employ only plant and working methods which 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.

Building Floor Slab – Completion of necessary cut / fill works, compaction of shallow granular soils and subsequent construction of a stiffened soil platform to ensure a net safe Allowable Bearing Pressure of 50kN/m² to achieve the settlement requirements of the Structural Engineer (nominally <25mm with differential settlement of <10mm) with the construction of a specialist 300mm sub-base replacement layer or placement of suitable aggregate to ensure a CBR >15% to the top of sub-base and >30% at MOT 1.

External Hardstand – Completion of all necessary cut / fill works, compaction of sub-grade and subsequent Engineering of a 300mm stiffened soil platform to ensure total settlement of <25mm with differential settlement of <10mm to achieve a CBR of >15% at formation and 30% at top of MOT1.

Preparation of Formation (all other areas) - Prior to the placement of any engineered soils, the formation area (reduced level excavation) will be assessed and certified as suitable to ensure the removal of all soft spots that would be defined as either soft / low strength cohesive or loose granular stratum to ensure all anthropogenic and natural stratum that remains in-situ exceeds the performance requirements.

The contractor will be responsible for proof rolling and where necessary Ground Improvement in the sub-stratum to ensure it is compacted with all potential variable stratum or soft spots to be removed and replaced with material that is engineered in accordance with the requirements of this specification.

In general, all soils (excluding certified recycled and quarried aggregates) must be engineered to achieve the following performance criteria:

- ✿ Compaction in excess of 95% of the Maximum Dry Density (MDD) defined using a 4.5kg rammer or 100% of the MDD derived from a 2.5kg rammer laboratory simulation;
- ✿ Maximum <5% air void ratio in engineered cohesive soils during uplift layers;
- ✿ Moisture content to be within 2% (+/-) of the defined optimum / control value;
- ✿ CBR to meet the required performance spec for the relevant stratum in each and every engineered soil layer; and,
- ✿ Maximum deformation under Plate Load to meet the geotechnical specification within each and every compacted layer.



TABLE 6.1 SPECIFICATION FOR GEOTECHNICAL ENGINEERING WORKS - GROUND BEARING FLOOR SLAB

CONSTRUCTION DETAIL	MATERIAL	TEST TYPE	FREQUENCY / 1 PER:	PERFORMANCE REQUIREMENT
MOT Sub-Base (Engineers Drawing)	MOT – Type 1	Max Deformation & CBR by Plate Load	1000 m ²	CBR to be >30% (structural engineer design)
		PSD	1000 m ³	Type MOT 1 Grading
		Frost Susceptibility	5000 m ³	<5% Heave
300mm Engineered Capping	Stabilised Subbase Replacement or Suitable Aggregate	Max Deformation & CBR by Plate Load	2000 m ²	>15% & <5mm settlement 200kN/m ²
		CBR by DCP	1000 m ²	>15%
		In-situ Density by NNDGT or SRD	625 m ²	>95% of Max DD (4.5kg)
Engineered Structural Up-Fill (Stabilised to control moisture as required)	Engineered Cohesive	In-situ Density by NNDGT or SRD	625 m ²	>100% of Max DD (2.5kg) <5% Air Voids >95% of Max DD (4.5kg) <5% Air Voids
		Max Deformation & CBR by Plate Load	4000 m ² (placed)	>3%
		CBR by DCP	1000 m ³	>5%
		Odometer (core)	10,000 m ³	<0.1 m ² /MN
	Engineered Granular	In-situ Density by NNDGT or SRD	650 m ²	>100% of Max DD (2.5kg) >95% of Max DD (4.5kg)
		Max Deformation & CBR by Plate Load	4000 m ² (placed)	>3%
		CBR by DCP	1000 m ³	>3%
Base of Formation	Granular or Cohesive	CBR by DCP	4000 m ²	>3%
		Hand Shear vane	500 m ²	Cu >30kN/m ²



TABLE 6.2 SPECIFICATION FOR GEOTECHNICAL ENGINEERING WORKS – EXTERNAL HARDSTAND

CONSTRUCTION DETAIL	MATERIAL	TEST TYPE	FREQUENCY / 1 PER:	PERFORMANCE REQUIREMENT
MOT Sub-Base (Engineers Drawing)	MOT – Type 1	Max Deformation & CBR by Plate Load	1000 m2	CBR to be >30% (structural engineer design)
		PSD	1000 m3	Type DOT 1 Grading
		Frost Susceptibility	5000 m3	<5% Heave
300mm Engineered Capping	Stabilised Subbase Replacement or Suitable Aggregate	Max Deformation & CBR by Plate Load	1000 m2	>30% & <6mm settlement 150kN/m2
		CBR by DCP	1000 m2	>15%
		In-situ Density by SRD or NNDGT	650 m2	>100% of Max DD (2.5kg) >95% of Max DD (4.5kg)
Base of Formation	Granular or Cohesive	CBR by DCP	1000 m2	>3%

Notes:

Maximum dry density shall be determined by obtaining representative samples of all material that will be engineered using laboratory determinations to confirm the Optimum Moisture Content & Maximum Dry Density for soils in either the unaltered or modified (stabilised) state.

CBR by Plate Load will utilise a 450mm Plate with the test to be conducted in strict accordance with BS1377 (Part 9). Note this will mean the loading of the test until all movement of the plate has stopped, i.e. until the average settlement rate is less than 0.02mm per 5 minute interval. A minimum modelled load of 150Kn/m2 will be applied to all PLT Testing for the purposes of this contract.

In-situ density method to be selected by the contractor with written approval required from the supervising organisation in terms of appropriateness of application.

The depth of differing stratum as indicated within the E3P specification is for guide purposes only and the contractor must refer to the Structural Engineers drawings for specific build up requirements.

Where soil is to be stabilised and used as an engineered fill material the contractor will be required to provide a site specific method statement for the proposed works to be fully inclusive of laboratory bench testing to demonstrate the suitability for use.



TABLE 6.3 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 Clays	> 100 kg metric ton 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



6.4.1. 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 150mm 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.

Prior to the additional of any stabilising agents, laboratory bench testing will be undertaken in accordance with the method and rationale as outlined within the DMRB HA74/07.

For any stabilisation works certain limiting factors must be considered by the contractor in their design:

-  Soils can only be stabilised through the addition of lime/OPC when the ambient air temperature is >7 degrees.
-  Ground temperatures cannot fall below 3 degrees.

In addition to any grading requirement for a material type 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 150mm shall not be deposited within the restored surface level unless directed otherwise by the Engineer.

Prior to the commencement of any works, the following laboratory tests are to be completed by the contractor to demonstrate suitability of materials for use as a structural fill and where required to provide bench testing to confirm the applicability of stabilisation agents.

6.4.2. 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 1,000m³ 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.

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 requirements, stabilising agents should be added to assess suitability for use to the contractors own design.



6.5. 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 6.4 COMPACTION/BACKFILL REQUIREMENTS

LAND USE requirement	COMPACTION METHODOLOGY and GENERAL PERFORMANCE CRITERIA
Traditional Spread Foundation	Ensure no disturbance of natural soil at shallow depth.
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 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). 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)	<i>Method Compaction – Highways Design Manual Series 600</i> is to be followed, with in-situ validation testing to meet requirement of adoptions authority. A CBR > 5% is required at subgrade formation (prior to placement of capping).
Estate Roads	<i>Method Compaction – Highways Design Manual Series 600</i> is to be followed to achieve a CBR > 5%.
Landscaping, POS and Other External Areas	Material is to be placed in layers not exceeding 300 mm and must be rolled using dedicated plant (no earth moving equipment) and in general compliance with the requirements of <i>Highways Design Manual Series 600</i> .

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

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

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

6.5.1. 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.

6.5.2. 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 *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.

6.5.3. 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.



6.6. 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 6.5.

TABLE 6.5 COMPACTION/BACKFILL REQUIREMENTS

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

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 course of the remediation and site enabling works.

7.2. VERIFICATION

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

The validation report will include the following:

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



8. CONTINGENCY PLAN

8.1. PREVIOUSLY UNIDENTIFIED CONTAMINANTS

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

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

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



9. SECOND PHASE MITIGATION AND MANAGEMENT – BUILD PHASE

This document details the construction works that are required to ensure full compliance with the remediation Strategy, Regulatory Authorities, Building Control & 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 landscaping;
- ✚ Placement and validation of sub-soil (clean material) in a 150mm layer within any plots where the material was not placed during the Remediation & Enabling works;
- ✚ Placement and chemical validation of imported topsoil within all landscaping; and,
- ✚ Installation and validation of ground gas 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:

- ✚ No dig break layer;
- ✚ 150mm subsoil; and,
- ✚ 150mm topsoil.

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

Landscaped areas need to be backfilled with 150mm chemically validated subsoil, with 150mm topsoil overlaying this. A break layer is required beneath the cover system. 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 300mm of clean material with break layer will be undertaken during the build phase works of the project.

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

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

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

E3P will collect photographic evidence of the placement of 150mm of certified topsoil and 150mm of subsoil on completion of construction works.

The landscape validation procedure is detailed in Table 9.2.



TABLE 9.2 LANDSCAPE VALIDATION PROCEEDURE

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. A break layer is required beneath the cover system. 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 the landscaping areas given that the 300mm cover system will need to be placed 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 and every 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 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 landscape validation photographs that will be required.



PLATE 1 EXAMPLE PLOT COVER SYSTEM VALIDATION

Plot No: 4 (Car Park Landscaping)

Depth of Strata (m bgl)

0.00-0.30

Validated TOPSOIL

Depth of Cover System Materials



Depth of Cover System Materials



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



9.2. GROUND GAS PROTECTION MEASURES

Ground gas monitoring and the ground gas assessment has suggested that the site will fall into the bracket for Characteristic Situation 2 and as such specialist mitigation measures are required 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

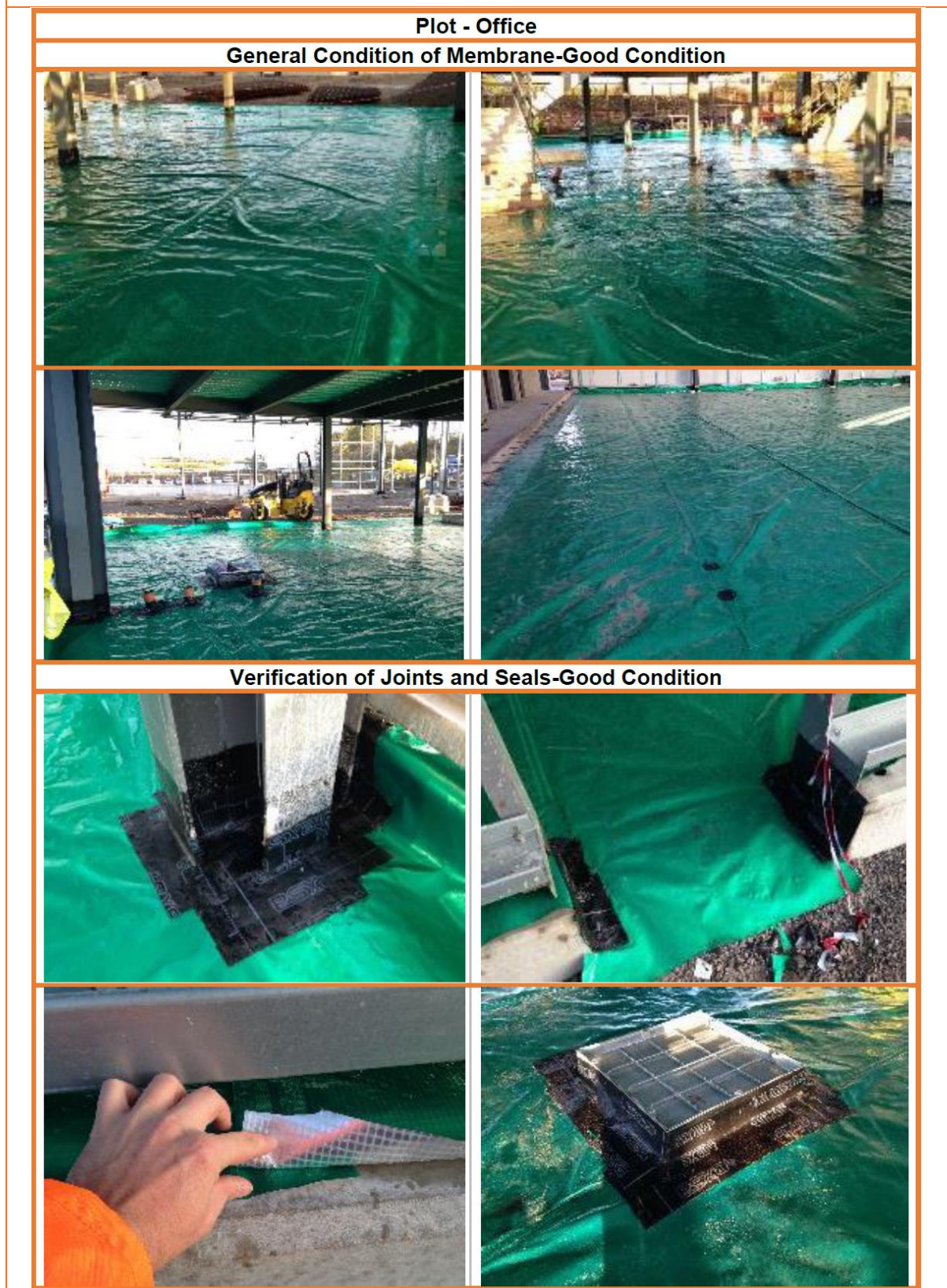
INSPECTION	METHOD
Product Verification	Confirmation that suitable products have been installed to consist of photographs of product types, labels on packaging and delivery tickets.
Wall Cavity Inspection	Confirmation that gas membrane spans the external wall cavity above the periscopic vents.
General 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



9.3. POTABLE WATER SUPPLY – CONTAMINANT ASSESSMENT CRITERIA

Contaminant Group	PE-threshold ^A
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

Notes

- A. All concentrations in mg/kg.

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



Pacific Park, Wrexham

Remediation and Enabling Works Strategy

July 2021

m	Metres	ppm	Parts per million
km	Kilometres	mg/m³	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/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	SSRT	Site Specific Remediation Target
PSD	Particle Size Distribution	DD	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	Mc	Moisture Content
ρ	Bulk Density	GPR	Ground Penetrating Radar
NDP	Nuclear Density Probe	FFL	Finished Floor Level
LEL	Lower Explosive Limit	UKWIR	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	LOD	Limit of Detection



APPENDIX III

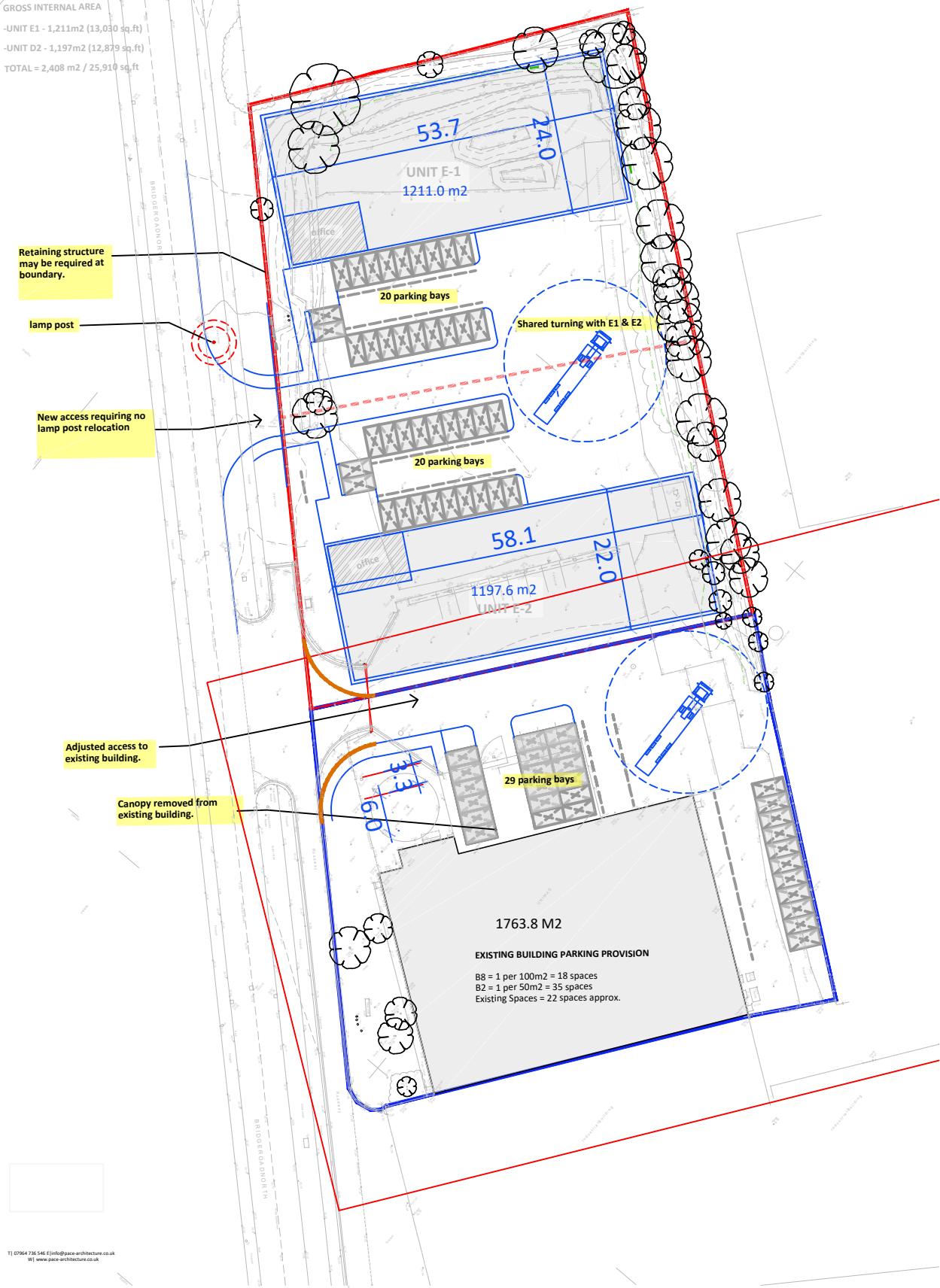
DRAWINGS

DRAWING 14-255-001 – SITE LOCATION PLAN



OPTION E Rev A

GROSS INTERNAL AREA
-UNIT E1 - 1,211m2 (13,030 sq.ft)
-UNIT D2 - 1,197m2 (12,879 sq.ft)
TOTAL = 2,408 m2 / 25,910 sq.ft



T: 0161 738 546 E: info@e3p.co.uk
W: www.e3p.co.uk



Notes:				
P1	REVA	06.07.2020	LM	BH
Phase	Issue	Date	Drawn	Checked

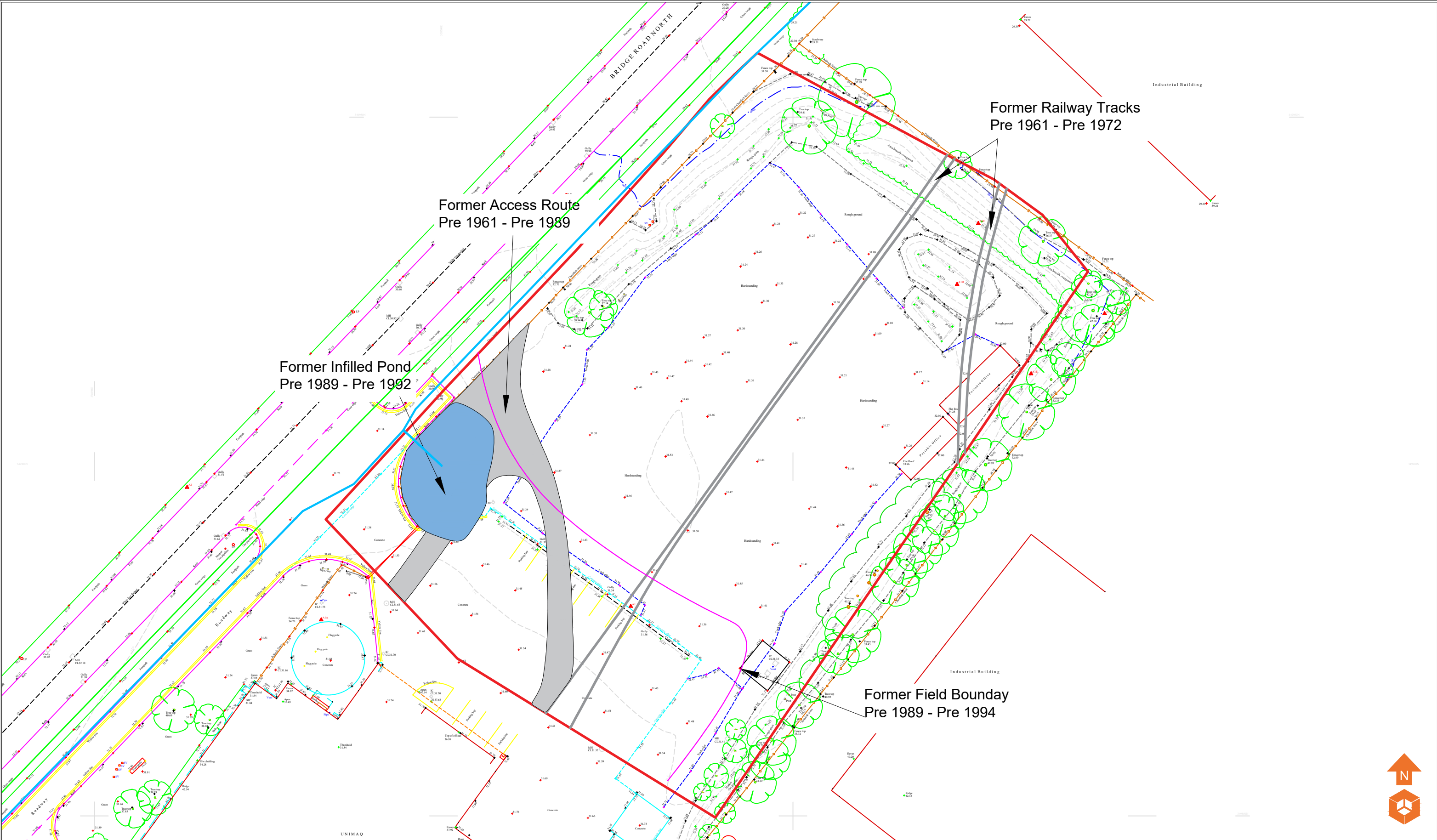
Client:	
Multimaq Ltd	
Job Title:	
Pacific Park, Wrexham	

Job No:	14-255	Date:	06.07.2020
Drawing No:	002	Scale:	NTS@ A3
Drawing Title:		Proposed Development Plan	



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
- Former Pond
 - Former Access Route
 - Former Railway Tracks
 - Former Field Boundary

Notes:				
P1	REVB	12.05.2021	EB	BH
P1	REVA	06.07.2020	LM	MJ
Phase	Issue	Date	Drawn	Checked

Client:
Multimaq Ltd
Job Title:
Pacific Park, Wrexham

Job No:
14-255
Drawing No:
003

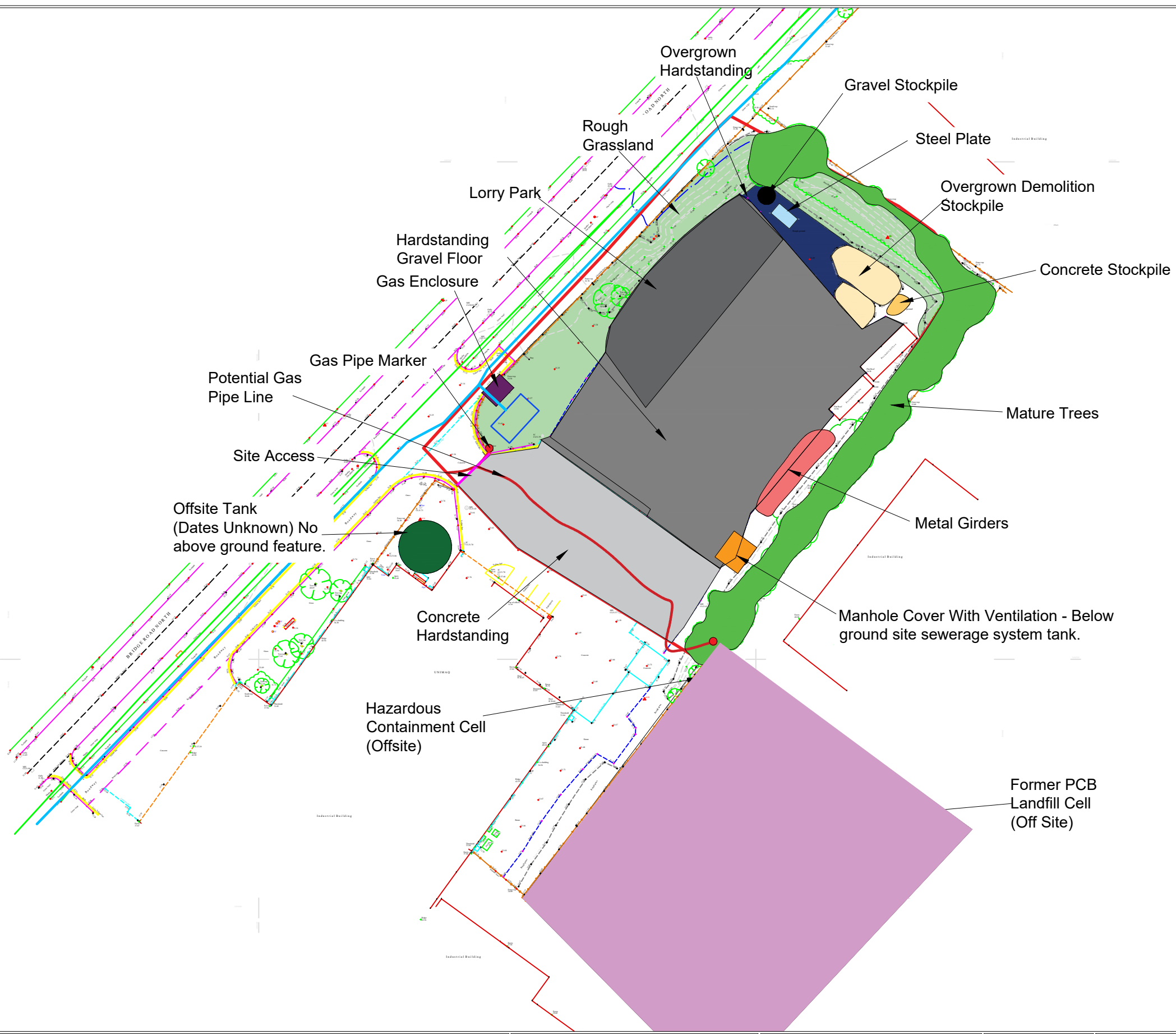
Date:
12.05.2021
Scale:
NTS

Drawing Title:
Historical Features Plan



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Site Features

Gravel Stockpile	Potential Gas Pipe	Offsite Containment Cell
Lorry Parking	Site Access	
Hardstanding Rubble	Steel plate	
Concrete Hardstanding	Former PCB Landfill Cell	
Overgrown Demolition StockPiles	Tank	
Concrete Stockpile	Overgrown Hardstanding	
Manhole Cover	Rough Grassland	
Metal Girders	Gas Enclosure	
Gas Pipe Marker		

Notes:

P1	REVE	12.05.2021	EB	BH
P1	REVD	21.04.2021	EB	BH
P1	REVC	31.07.2020	HM	BH
P1	REVB	30.07.2020	LM	BH
P1	REVA	06.07.2020	LM	MJ
Phase	Issue	Date	Drawn	Checked

Client:

Multimaq Ltd

Job Title:

Pacific Park, Wrexham

Job No:

14-255

Drawing No:

004

Date:

12.05.2021

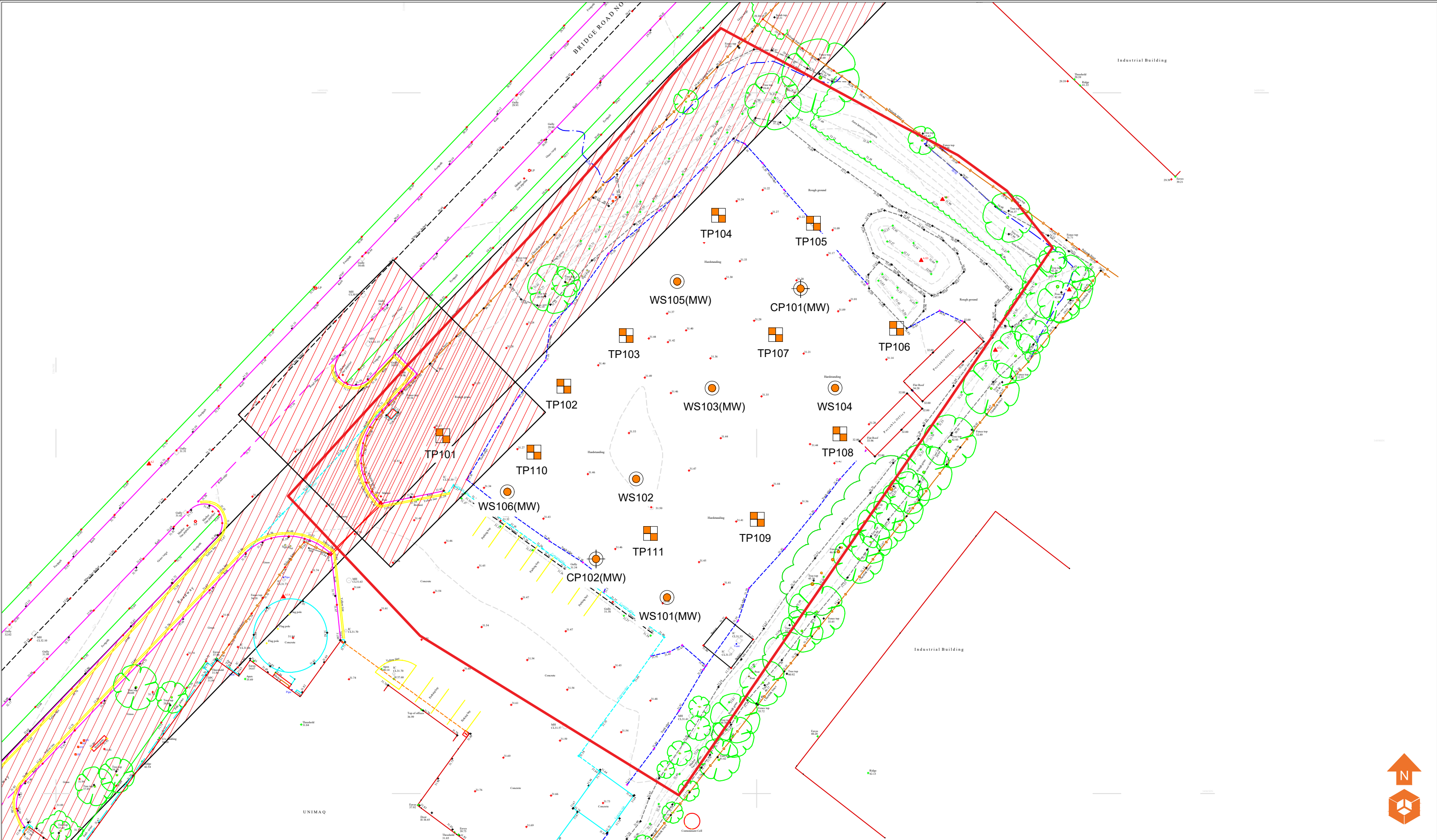
Scale:

NTS@ A3

e3p

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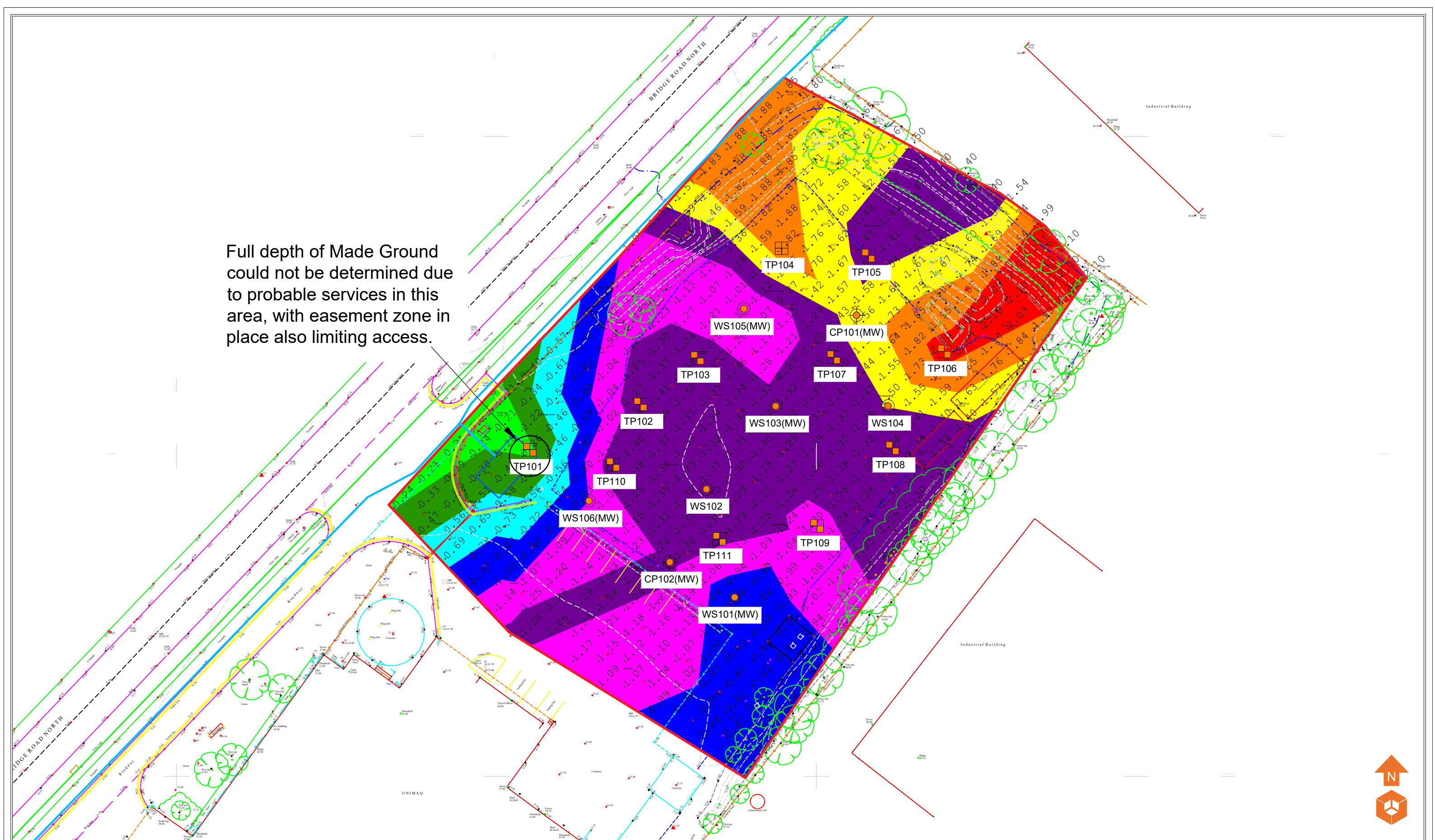
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Location Symbols Approximate Window Sample Probehole Location Approximate Window Sample Probehole Location with Install Approximate Trial Pit Location Approximate Cable Percussive Borehole Location Approximate Cable Percussive Borehole Location with Install Gas Main Easement / Gas Governor Box	Notes:	Client: Multimaq Ltd	Job No: 14-255	Date: 12.05.2021	Environmental Engineering Partnerships Ltd City Heliport & Business Centre Eccles, Manchester, M30 7RU Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk
P1 REV B 12.05.2021 EB BH P1 REV A 26.02.2021 EB MJ Phase Issue Date Drawn Checked	Job Title: Pacific Park, Wrexham	Drawing No: 005	Scale: NTS	Drawing Title: Exploratory Hole Location Plan	

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Full depth of Made Ground could not be determined due to probable services in this area, with easement zone in place also limiting access.



Location Symbols		Made Ground Depth (m)	
	Approximate Window Sample Probehole Location		Depth of Made Ground 0.00 - 0.24m
	Approximate Window Sample Probehole Location with Install		Depth of Made Ground 0.25 - 0.49m
	Approximate Trial Pit Location		Depth of Made Ground 0.50 - 0.74m
	Approximate Cable Percussive Borehole Location		Depth of Made Ground 0.75 - 0.99m
			Depth of Made Ground 1.00 - 1.24m
			Depth of Made Ground 1.25 - 1.49m
			Depth of Made Ground 1.50 - 1.74m
			Depth of Made Ground 1.75 - 1.99m
			Depth of Made Ground >2.00m

Full Depth of Made Ground Not Proven

Notes:				
P1	REVC	12.05.2021	EB	BH
P1	REVB	21.04.2021	EB	BH
P1	REVA	26.02.2021	EB	MJ
Phase	Issue	Date	Drawn	Checked

Client:		Job No:	Date:
Multimaq Ltd		14-255	12.05.2021
		Drawing No:	Scale:
		006	NTS@ A3
Job Title:		Drawing Title:	
Pacific Park, Wrexham		Depth Of Made Ground Plan	

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Services and easement
restricted access however
founding depth likely circa
1.75mbgl into natural CLAY
stratum.

Former Pond



Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Cable Percussive 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

○ Full Depth of Founding Strata Not Identified

Notes:				
P1	REVc	12.05.2021	EB	BH
P1	REVB	21.04.2021	EB	BH
P1	REVA	06.04.2021	EB	MJ
Phase	Issue	Date	Drawn	Checked

Client:

Multimaq Ltd

Job No:

14-255

Date:

21.05.2021

Drawing No:

008

Scale:

NTS

Job Title:

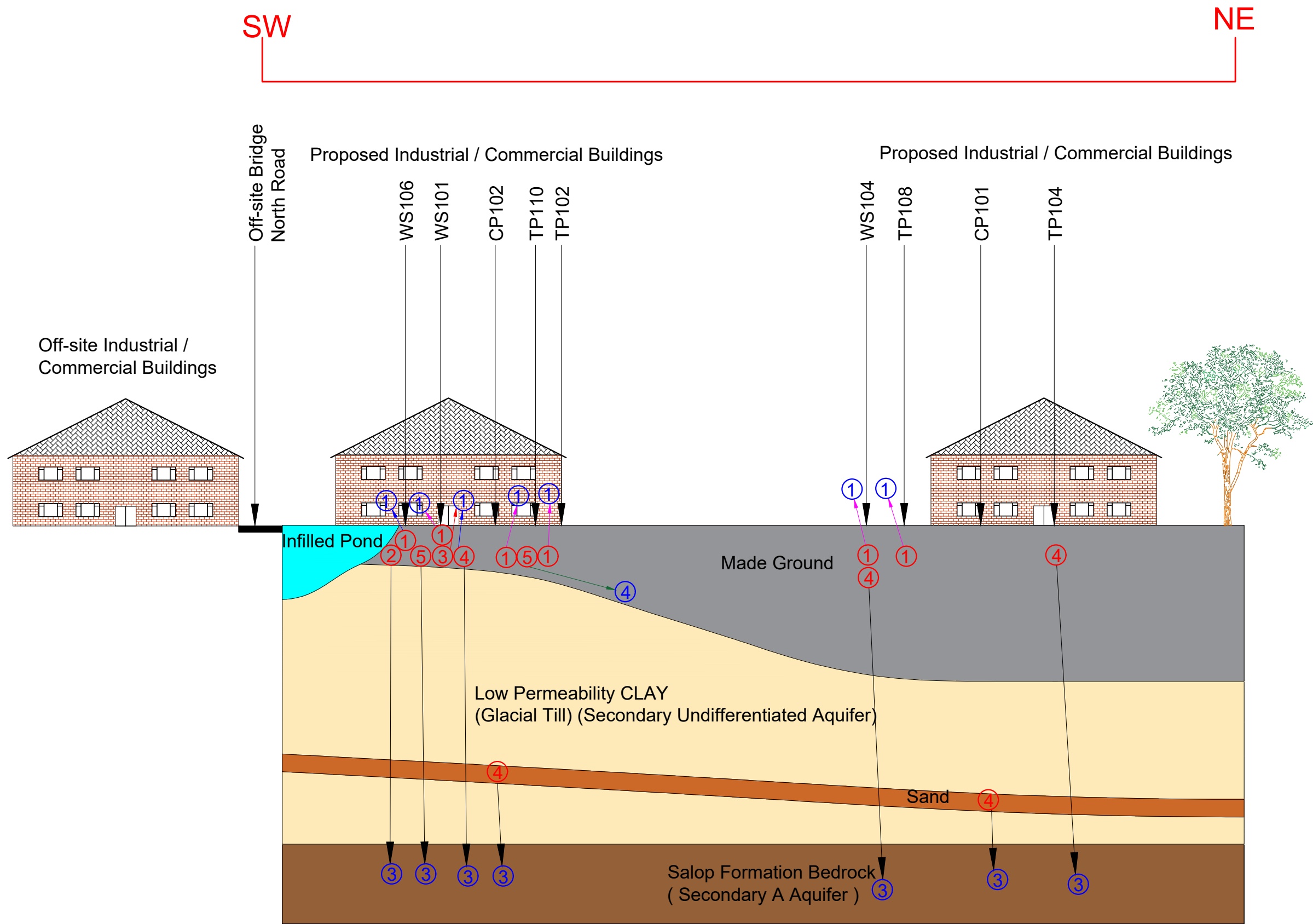
Pacific Park,
Wrexham

Drawing Title:

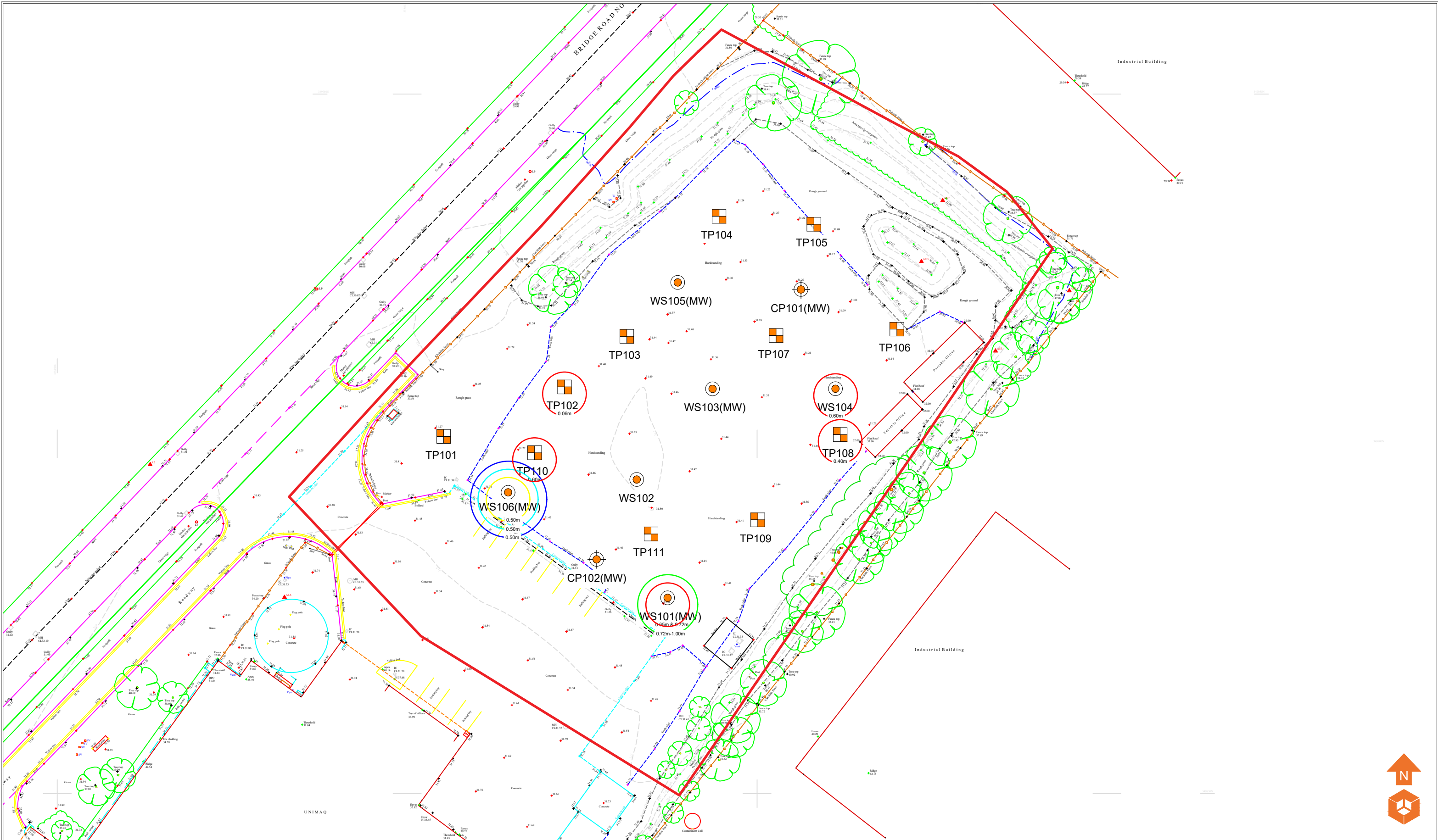
Depth Of Founding
Strata Plan

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Geology Key Made Ground Clay Bedrock Infilled Pond Off-site Bridge Sand
--



- Location Symbols**

 - Approximate Window Sample Probehole Location
 - Approximate Window Sample Probehole Location with install
 - Approximate Trial Pit Location
 - Approximate Cable Percussive Borehole Location
 - Approximate Cable Percussive Borehole Location with install
- Elevated Concentrations of Contaminants of Concern**

 - Asbestos
 - PCB's
 - Benzo(b) Fluoranthene
 - Benzo(a) Pyrene
 - Dibenzo(a,h) Anthracene

Notes:				
P1	REVB	12.05.2021	EB	MJ
P1	REVA	06.04.2021	EB	MJ
Phase	Issue	Date	Drawn	Checked

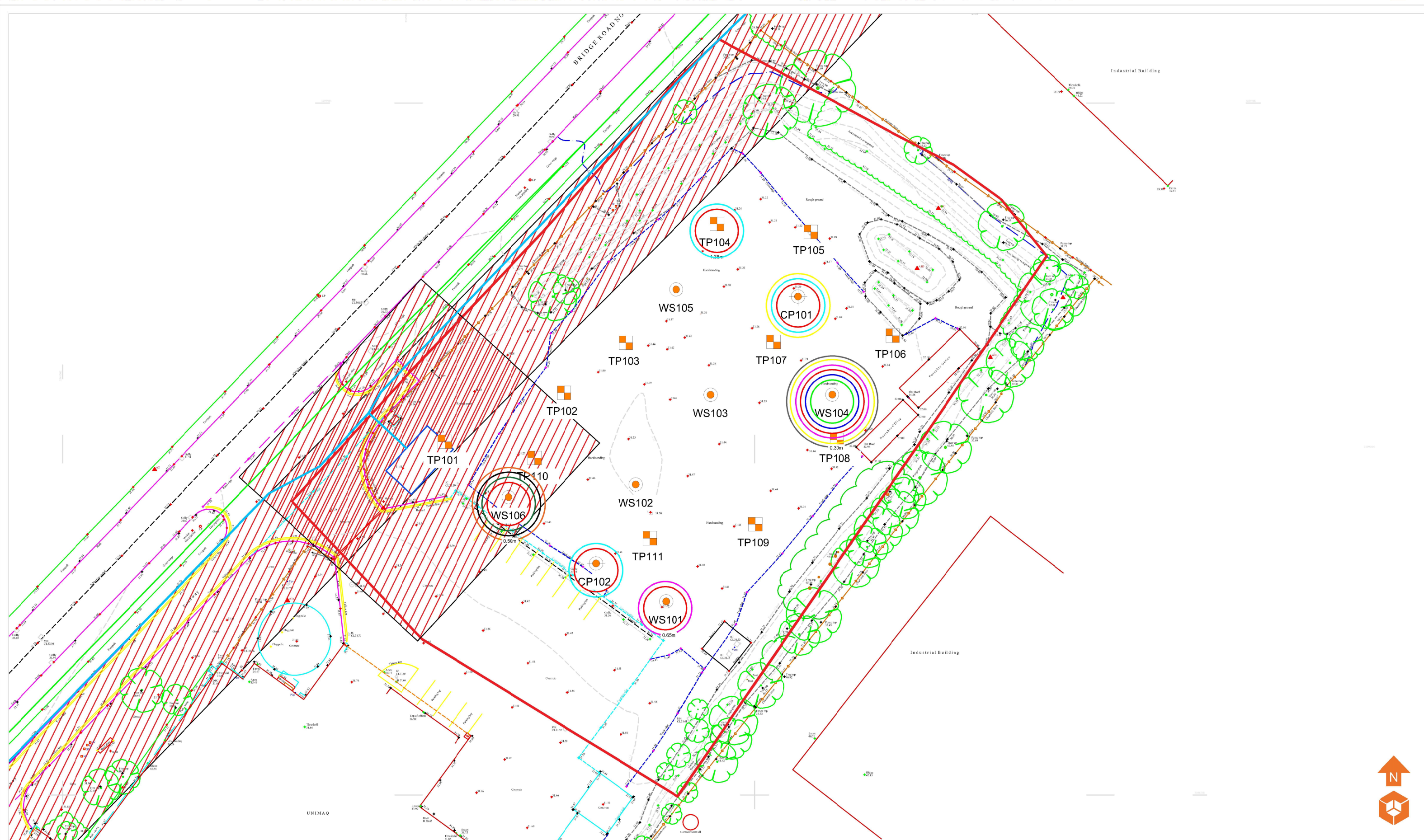
Client:	
Multimaq Ltd	
Job Title:	
Pacific Park, Wrexham	

Job No:	Date:
14-255	12.05.2021
Drawing No:	Scale:
018	NTS
Drawing Title:	
Contamination Issues Plan - Soils	



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Location Symbols

- Approximate Window Sample Probeshole Location
- Approximate Trial Pit Location
- Approximate Cable Percussive Borshole Location

Contaminations

- Copper
- Chromium VI
- Lead
- Zinc
- Chromium III
- Nickel
- Elevated PH
- Naphthalene
- Anthracene
- Flouranthene TPH C12-C16

Notes:

P1	REVB	21.04.2021	EB	BH
P1	REVA	06.04.2021	EB	MJ
Phase	Issue	Date	Drawn	Checked

Client:

Portal
Construction

Job Title:

Pacific Park,
Wrexham

Job No:

14-255

Drawing No:

019

Date:

21.04.2021

Scale:

NTS

Drawing Title:

Contamination Issues
Plan - Leachate and
Waters



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APPENDIX IV E3P REMEDIATION/ VALIDATION CRITERIA

HUMAN HEALTH REMEDIATION TARGETS – INDUSTRIAL / COMMERCIAL USE

DETERMINAND	UNITS	WITHIN 300 mm COVER SYSTEM (POS)	UNDER HARD STANDING AND >300 mm TO 1.0M BELOW COVER SYSTEM	PATHWAY
Arsenic ^(vii)	mg/kg	79	640	1
Cadmium ^(vii)	mg/kg	120	190	1
Chromium (Hexavalent)	mg/kg	7.7	33	1
Lead ^(vii)	mg/kg	200	2300	1
Elemental Mercury	mg/kg	16	58	2
Nickel	mg/kg	230	980	1
Selenium	mg/kg	1100	12000	1
Copper	mg/kg	12000	68000	1
Zinc	mg/kg	81000	730000	1
Cyanide	mg/kg	791	791	1
Phenol	mg/kg	120	440	2
Asbestos	Fibres	NFD	≤0.001	4
Naphthalene	mg/kg	4900	190	2
Acenaphthylene	mg/kg	15000	83000	3
Acenaphthene	mg/kg	15000	84000	1
Fluorene	mg/kg	9900	63000	1
Phenanthrene	mg/kg	3100	22000	3
Anthracene	mg/kg	74000	520000	3
Fluoranthene	mg/kg	3100	23000	3
Pyrene	mg/kg	7400	54000	3
Benzo(a)Anthracene ^(c)	mg/kg	29	170	3
Chrysene	mg/kg	57	350	3
Benzo(b)Fluoranthene	mg/kg	7.1	44	3
Benzo(k)Fluoranthene	mg/kg	190	1200	3
Benzo(a)Pyrene	mg/kg	5.7	35	3
Indeno(123-cd)Pyrene	mg/kg	82	500	3
Dibenzo(a,h)Anthracene	mg/kg	0.57	3.5	3
Benzo(ghi)Perylene	mg/kg	640	3900	3
TPH C5-C6 (aliphatic)	mg/kg	570000	3200	2
TPH C6-C8 (aliphatic)	mg/kg	600000	7800	2
TPH C8-C10 (aliphatic)	mg/kg	13000	2000	2
TPH C10-C12 (aliphatic)	mg/kg	13000	9700	2
TPH C12-C16 (aliphatic)	mg/kg	13000	59000	1
TPH C16-C35 (aliphatic)	mg/kg	250000	1600000	1
TPH C5-C7 (aromatic)	mg/kg	56000	26000	1
TPH C7-C8 (aromatic)	mg/kg	56000	56000	2
TPH C8-C10 (aromatic)	mg/kg	5000	3500	2
TPH C10-C12 (aromatic)	mg/kg	5000	16000	2
TPH C12-C16 (aromatic)	mg/kg	5100	36000	2
TPH C16-C21 (aromatic)	mg/kg	3800	28000	1
TPH C21-C35 (aromatic)	mg/kg	3800	28000	1
1,2 Dichloroethene	mg/kg	29	0.67	1
Trichloroethane	mg/kg	140000	660	1
1122 Tetrachloroethane	mg/kg	1400	270	1
1112 Tetrachloroethane	mg/kg	1400	110	1
Tetrachloroethene	mg/kg	1400	19	1
Tetrachloromethane	mg/kg	890	2.9	1



Pacific Park, Wrexham

Remediation and Enabling Works Strategy

July 2021

Trichloroethene (TCE)	mg/kg	120	1.2	1
Trichloromethane	mg/kg	2500	99	1
Chloroethene	mg/kg	3.5	0.059	1
Polychlorinated Biphenyls (PCB)	mg/kg	20	7.2	1

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.

Tier 1 values for POS (resi) used for any imported soils used for cover system;

Commercial Tier 1 GAC modelled to assume no exposure pathway; and,

No viable exposure pathway beneath hard standing and cover system. Exceedance of target level should be subject to further risk assessment.

Notes 3

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

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

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



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

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}	DWS ^{3,4,5}
		AA	
Arsenic	µg/l	50	10
Cadmium	µg/l	0.08-0.25	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	10
Mercury	µg/l	–	1.0
Nickel	µg/l	4	20
Selenium	µg/l	–	10
Zinc	µg/l	10.9	–
pH		6–9	
Naphthalene	µg/l	2	10*
Anthracene	µg/l	0.1	
Benzo[b]fluoranthene	µg/l	0.00017*	
Benzo[k]fluoranthene	µg/l	0.00017*	
Benzo(a)pyrene	µg/l	0.00017*	
Indeno(123-cd)pyrene	µg/l	0.00017*	
Benzo(ghi)pyrene	µg/l	0.00017*	
Fluoranthene	µg/l	0.0063	
Benzo(ghi)perylene	µg/l	1.7–4	
TPH C5-C6 (benzene)	µg/l	10	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	90 ⁵
TPH C16-C35	µg/l	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



Pacific Park, Wrexham**Remediation and Enabling Works Strategy**

July 2021

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}	DWS ^{3,4,5}
		AA	
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

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

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

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



APPENDIX V

E3P MATERIAL IMPORT CRITERIA

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



APPENDIX VI CONTRACTOR PRE- COMMENCEMENT CHECK SHEET

GEOTECHNICAL ENABLING WORKS PRE-START FORM

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

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



Pacific Park, Wrexham

Remediation and Enabling Works Strategy

July 2021

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.



