



PHASE I AND PHASE II GEO-ENVIRONMENTAL SITE ASSESSMENT

**Blackley Mere
Blackley
Manchester
M8 4LL**

Prepared for:

Endeavour

Report Ref: 11-164-R1
Date Issued: October 2016



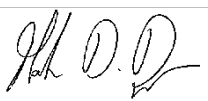
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EXECUTIVE SUMMARY

Site Address	Blackley Mere, Bowker Bank Avenue, Manchester M8 4LL	
Grid Reference	E 383980, N 403010	
Site Area	3.16 Ha	
Current Site Use	The site is an irregular shaped parcel of land located off Bowker Bank Avenue, Blackley approximately 4km north of Manchester City Centre. The site comprises two distinct sectors; the western portion predominantly occupied by a drained reservoir basin which sits c. 4-5m higher in elevation than the eastern sector which comprises a concrete slab associated with the former site works.	
Proposed Development	E3P understands that site will be developed with the construction of 76 No. dwellings with associated access and estate roads, driveways, garden and landscaped areas and adopted utility infrastructure.	
Previous Reports	E3P has not been provided with any previous reports for the site.	
Environmental Setting	<i>Drift Geology</i>	West - Glacial Till (Clay) East - Alluvium (Sand & Gravel)
	<i>Bedrock Geology</i>	Cheshire Pebble Beds Formation (Sandstone).
	<i>Hydrogeology</i>	Unproductive (west) / Secondary A (east) overlying Principal Aquifer (bedrock).
	<i>Groundwater Source Protection</i>	The site is not located within a Groundwater Source Protection Zone or Drinking Water Safeguard Zone.
	<i>Hydrology</i>	The River Irk lies downgradient immediately adjacent to the north and eastern site boundary.
	<i>Flood Risk</i>	The SE sector is affected by flooding from rivers (FZ3). Remaining area unaffected by flooding (FZ1).
	<i>Ecology</i>	Potential risk to ecological and aquatic ecosystems within River Irk.
	<i>Sensitive Land Uses</i>	The River Irk is considered a critical receptor.
	<i>Industrial Land Use</i>	No industrial land uses identified on-site or the immediate locality that may potentially prejudice the future development of the site for residential use.
	<i>Subsidence Hazard</i>	Moderate compressible ground hazard to the NE; Moderate landslide hazard to the SE.
Site History	A review of the pertinent Ordnance Survey mapping dating from late 1850s confirms the presence of the reservoir and print works which later became a bleach works and more recently a textile works.	
Utility Locations	A review of service plans has indicated that drainage infrastructure is present within Bowker Bank Avenue to the west.	
Landfill Sites & Ground Gases	A historic landfill site is located to the northeast of the site on the opposite side of the River Irk. Made Ground associated with the landfill to the NE and in-filled reservoirs on-site may be a source of hazardous ground gas and may pose a low-level risk to construction workers and residential end users.	
Radon	Unaffected – No special precautions required.	
Coal Mining / Land Stability	The site is not located within an area deemed to be at risk from ground instability arising from historic coal mining activities.	

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E3P Intrusive Ground Investigation

Ground Conditions	E3P completed a Ground Investigation comprising 12 No. Window Sample Probeholes and 25 No. mechanically excavated Trial Pits. The ground conditions encountered are summarised below: Topsoil A 250mm horizon of gravelly SILT (Topsoil) was encountered at TP114. Made Ground Made Ground was encountered within all exploratory locations to a maximum proven depth of 3.45m bgl (WS112) underlying the former bleach works, although generally to depths in excess of 1.0m bgl across the wider site. Made Ground deposits were generally uniform and comprised a silty and/or sandy gravel of concrete, brick, ash, mudstone, sandstone, slate, plastic, timber and metal believed to be associated with historic fill material resulting from construction and demolition activities. Localised discontinuous sandy and/or gravelly clay soils and reworked sand were recorded. Drift Drift deposits were encountered within all exploratory hole locations where the Made Ground could be fully penetrated to a proven depth of 5.45m bgl and generally comprised a silty and/gravelly dense SAND with localised areas of sandy SILT within the eastern portion in close proximity to the River Irk. A number of stiff to very stiff medium to high strength gravelly CLAY bands were recorded underlying the Made Ground soils, typically across the central portion of the site. Solid No solid geology was encountered as part of the site investigation. Groundwater Groundwater has been recorded at depths of 0.50-3.50m bgl; generally shallower in close proximity to the River Irk.
Human Health	The preliminary Tier I Human Health risk assessment has identified the presence of site wide elevated heavy metals, non-volatile PAHs / TPH compounds and asbestos within the Made Ground soils. Asbestos has been identified within the shallow Made Ground, and as such it will be necessary to carefully manage these impacted soils and place them in a legislatively compliant manner that will negate any possibility of future exposure. External areas will be covered by hard-standing or a chemically suitable cover system within all private garden and landscaped areas thereby removing the exposure pathway to future site users. It is possible that as yet unidentified hydrocarbon impact is present within localised hotspots underlying the existing structures and location of former tanks. It is considered that any such contamination could be addressed by the delineation, excavation and treatment of impacted soils.
Controlled Waters	Given the absence of any elevated soluble contaminants within the groundwater or River Irk and thus a complete pollutant linkage the site is not deemed to pose a significant degree of risk to controlled waters.

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Ground Gas	Ground gas monitoring to date (ongoing) indicates the site falls into classification Characteristic Situation 2 / Amber 1 due to elevated carbon dioxide concentrations and special precautions will be required as part of the residential development.
Radon	Unaffected – No special protection measures required.
Potable Water Infrastructure	It is considered that a well designed and implemented programme of remediation and enabling works should negate the need for contaminant resistant infrastructure. A full UKWIR assessment will be required.

Geotechnical Assessment

Underground Obstructions	Extensive buried obstructions have been encountered and the presence of further relict foundations is anticipated. These features pose a constraint and will require grubbing out in their entirety as part of the proposed residential development to facilitate the construction of a suitable development platform.
Allowable Bearing Pressure (ABP)	It is anticipated that on completion of the proposed site remediation and enabling works, the ground will generally comprise circa 2.00-3.00m of variable Made Ground. The Made Ground is not considered suitable founding stratum (in its current condition) due to its inherent variability and unquantifiable potential for long term total and differential settlement. The natural stiff to very stiff medium-high strength gravelly CLAY and loose to medium dense SAND have been assessed and at a depth of between 3.00-5.45m bgl a variable ABP of between 50-190kN/m² can be achieved.
Foundation Options	The presence of variable Made Ground and localised very loose sands within the near surface drift deposits to depths of ~3.0m would indicate that (based on current elevations) the depth to competent founding stratum would preclude the use of a traditional spread (strip / trench fill) type foundation. It is therefore recommended that due consideration be given to the use of vibro replacement stone columns or a piled foundation capable of transferring structural loads to competent stratum. However, the final foundation solution will be dependent on the structural loadings and elevation and should be designed by a suitably qualified structural engineer.
Building Floor Slabs	Ground bearing floor slabs are not viable given the depth of Made Ground and compressible alluvial deposits.
Heave Precautions	Given the localised underlying clay is of low plasticity and low volume change potential, heave precautions will not be required to the internal face of a foundation. However, heave precautions will be required to the underside of floor slabs (where there is no 200mm void) or ground beams within the modelled influencing distance of trees.
Soakaway Drainage	The underlying predominantly granular drift deposits are likely to provide the required degree of infiltration to make soak-away drainage infrastructure viable on this site. However full BRE 365 test will be required if the use of soak-away drainage is considered.
Sulphate Assessment	This site meets Class DS-1 and (ACEC) AC-1s. However, localised areas which meet Class DS-2 and (ACEC) AC-2s have been encountered.

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CBR Design %	It is considered that the shallow Made Ground soils can be re-engineered in accordance with Class 1 (a-c) material under favourable climatic conditions to achieve a CBR of 2-4%. Where compressible ground is present to the northeast of the site, beneath proposed roads, adopted drainage infrastructure, driveways and hard stand consideration must be given to the potential for consolidation which will induce unacceptable degrees of total and differential settlement at the surface. It is therefore likely that the compressible alluvial deposits will need to be excavated where present beneath proposed infrastructure.
Cut / Fill	Development levels unknown at this time, however due to significant elevation changes between the eastern and western sector, a substantial cut / fill exercise will be required in order to create a suitable graded development platform for the proposed residential development.
Waste Characterisation	Stable Non-Reactive - Non-Hazardous / Inert; and ACM may be Hazardous (depending on quantification analysis).
Invasive Plants	Extensive infestations of Japanese Knotweed are present at the site boundaries with the adjacent river. A programme of treatment, eradication and continued control will need to be established prior to the commencement of any works in this area. All invasive plant species should be fenced at the first available opportunity.
Recommendations	Based on the findings of the intrusive site investigation, the following additional works are recommended to be completed in due course:  Specification for the eradication of invasive plants and long term maintenance;  Further assessment for Sodium Hypochlorite and SVOCs within footprint of former the bleach works (post sub-structure demolition);  Further assessment for PCBs in proximity to electrical substation (post demolition);  Remediation & Enabling Works Strategy;  Arboriculture Survey;  Plot Specific Foundation Schedule (upon receipt FFLs);  Geotechnical Earthworks Compaction Specification (Infrastructure);  Foundations to be designed by suitably qualified Structural Engineer.

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APPENDICES

Appendix I Limitations

Appendix II Glossary

Appendix III Drawings

Drawing No 11-164-001 – Site Location Plan
Drawing No 11-164-002 – Historical Site Features Plan
Drawing No 11-164-003 – Exploratory Hole Location Plan
Drawing No 11-164-004 – Proposed Development Scheme
Drawing No 11-164-005 – Conceptual Site Model
Drawing No 11-164-006 – Depth of Made Ground Plan
Drawing No 11-164-007 – Depth to Founding Stratum

Appendix IV Photographs

Appendix V Historical Maps

Appendix VI E3P Exploratory Hole Logs

Appendix VII Chemical Testing Results

Appendix VIII Geotechnical Testing Results

Appendix IX Origin of Tier I Generic Assessment Criteria

1. INTRODUCTION

1.1 Background

E3P has been commissioned by Endeavour to undertake a detailed Phase I & II Geo-Environmental Site Assessment for a parcel of land located off Bowker Bank Avenue, Blackley, Manchester; herein referred to as **the site**.

This report is required to determine potential contaminated land liabilities and geotechnical engineering works that will be required as part of the proposed residential development.

The scope of work consisted of the following key elements.

-  Detailed Desk Study & Design of Suitable Intrusive Ground Investigation;
-  12 No. Window Sample Probeholes & 10 No. Environmental Monitoring Installations;
-  25 No. Mechanically Excavated Trial Pits;
-  In-Situ Geotechnical Testing & Chemical & Geotechnical Laboratory Analysis;
-  Groundwater Sampling & Ground Gas Monitoring;
-  Contamination Risk Assessment & Conceptual Site Model;
-  Geotechnical Assessment & Interpretation; and,
-  Factual & Interpretive Reporting.

1.2 Proposed Development

E3P understands that Endeavour are involved with respect to the proposed redevelopment of the site for residential use comprising the construction of 76 No. dwellings with associated access and estate roads, driveways, garden and landscaped areas and adopted utility infrastructure.

The Indicative Development Scheme is presented in the excerpt Figure 1.1 below and presented in Drawing No 11-164-004 (Appendix II).

Figure 1.1 – Indicative Development Scheme



1.3 Objectives

The objectives of the Geo-Environmental Investigation are to:

-  Review historical plans, geology, hydrogeology, site sensitivity, flood-plain issues, mining records and any local authority information available in order to complete a Desk Study in line with Environment Agency (EA) document Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11));
-  Undertake a stage of sampling and analysis to provide an overview of environmental issues identified;
-  Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors;
-  Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs; and,
-  Provide recommendations regarding future works required.

1.4 Limitations

The limitations of this report are presented in Appendix I.

1.5 Confidentiality

E3P has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.

1.6 Previous Reports

E3P has not been provided with any previous reports for the site.

2. SITE SETTING

2.1 Site Details

Site Address	Blackley Mere, Bowker Bank Avenue, Manchester M8 4LL
National Grid Reference	E 383980, N 403010
Site Area	3.16 Ha

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

A site location map is presented in Appendix III as Drawing 11-164-001.

2.2 Current Site Use

SITE DESCRIPTION	
Occupancy / Use	The site is an irregular shaped parcel of land located off Bowker Bank Avenue, Blackley approximately 4km north of Manchester City Centre. The site comprises two distinct sectors; the western sector predominantly occupied by a former (drained) reservoir basin which sits c. 4-5m higher in elevation than the eastern sector which comprises a flat concrete slab associated with a former print works, bleach and dye works and textile works.
Structures	A two-storey brick built structure remains in the south-central sector which housed the former site offices.
Access	Access is via a lane leading from Bowker Bank Avenue.
Slope	The eastern sector is generally flat lying land adjacent to the River Irk. The western sector sits atop a 4-5m high embankment with raised bunds associated with a historic reservoir.
Retaining Structures	A 4-5m embankment splits the eastern and western sector of the site, within which adjacent to the access gate lies a sandstone and brick built retaining wall.
Surface Cover (%)	<i>Buildings:</i> <5
	<i>Hardstand:</i> 30
	<i>Soft cover:</i> 55
Trees	Mature and semi-mature trees are present around the periphery of the site.
Invasive Plant Species	Extensive infestations of Japanese Knotweed are present at the site boundary, therefore a controlled programme of treatment, eradication and control is necessary.
Hazardous Material Storage	No Above Ground Storage Tanks (AST) were noted at the site. However, historic storage tanks associated with the former works are recorded and remnant concrete bunds were noted adjacent to the former site office. No Underground Storage Tanks (UST) were observed at the site.
Asbestos Containing Material (ACM)	No ACM was observed during the site walkover, however given the age of the structures on site the presence of ACM within the building fabric and underlying Made Ground cannot be discounted.
Polychlorinated Biphenyl (PCB)	An electrical substation is located in the eastern sector of the site adjacent to the former site office which may potentially contain PCBs.
Waste Storage	No potentially hazardous waste streams are generated at the site.
Drainage	A review of service plans has indicated that drainage infrastructure is present within Bowker Bank Avenue to the west.

SITE DESCRIPTION

Surrounding Area	<i>North</i>	River Irk and Residential Properties.
	<i>East</i>	River Irk and Undeveloped Land.
	<i>South</i>	Undeveloped Land and Residential Properties.
	<i>West</i>	Angling Pond and Undeveloped Land / Residential Properties.

3. SITE HISTORY

3.1 On-Site Historical Development

A review of historical mapping pertinent to the site is summarised in Table 3.1 below. In addition, historical site features are presented on Drawing No 11-164-002 in Appendix III.

Table 3.1 Historical Development

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1893 (1:2,500)	The Bowker Bank Print Works occupies the eastern sector of the site (since 1848) with a number of small surrounding <i>reservoirs</i>. A larger reservoir is recorded in the western sector.	
1909 (1:2,500)	A new <i>reservoir</i> is recorded in the NE sector and chimney is recorded at the southern boundary. No other significant changes recorded.	
1922 (1:2,500)	The built environment is denoted as Bowker Bank Works (Bleaching, Dyeing & Finishing). A number of smaller structures have been demolished and the orientation of the buildings has changed with associated <i>tanks</i>. No other significant changes recorded.	
1952 (1:2,500)	A tank and overhead crane are recorded in the north of the site. No significant changes recorded.	
1992 (1:2,500)	The two main structures have been extended and a number of above ground tanks are recorded at the southern boundary. No other significant changes recorded.	

3.2 Off-Site Historical Development

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 250m radius of the site is summarised below in Table 3.2.

Table 3.2 Surrounding Contaminative Uses

SURROUNDING FEATURE	DISTANCE	DATES	DIRECTION
Reservoir <i>... Then Infilled</i>	20m	Pre 1909 – Pre 1999 Pre 1999 – Present	North
Waterside Bleach Works <i>... Then Unspecified Works</i> <i>... Then Residential</i>	245m	Pre 1932 – Pre 1978 Pre 1978 – Pre 2015 Pre 2015 – Present`	N / NW
Electrical Substation	130m	Pre 1971 – Present	North
Electrical Substation	140m	Pre 1971 – Present	North

3.3 Planning History

E3P has undertaken a detailed search of on-line planning records held by Manchester City Council and no environmentally pertinent information was highlighted.

3.4 Anecdotal Information

No anecdotal geotechnical or environmentally pertinent information was identified following a web-based search of the area.

4. ENVIRONMENTAL SETTING

4.1 Geology and Hydrogeology

The British Geological Survey (BGS) map for the site indicates that the site is underlain by the following geological sequence:

GEOLOGICAL UNIT	CLASSIFICATION	DESCRIPTION	AQUIFER CLASSIFICATION
Drift <i>Western Sector</i>	Glacial Till – Diamicton	Clay	Secondary <i>Undifferentiated</i>
Drift <i>Eastern Sector</i>	Alluvium	Clay, Silt, Sand and Gravels	Secondary A
Solid	Cheshire Pebble Beds Formation	Sandstone	Principal

E3P has reviewed the BGS online records, however there are no borehole scans available within close proximity to the site from which to confirm the published BGS mapping (above).

The study site is not located within a Groundwater Source Protection Zone or Drinking Water Safeguard Zone.

The nearest groundwater abstraction borehole is located 469m east for general cooling purposes. There are no potable groundwater abstraction licenses within a 1.0km of the site.

Based on the local topography and location of surface watercourses it is considered likely that shallow groundwater, if present, will flow in a north-easterly / easterly direction, following the topographical gradient towards the River Irk.

4.2 Geotechnical Data

Geotechnical Data presented within the Envirocheck report identifies the following ground conditions:

HAZARD	DESIGNATION
Shrink-Swell Clay	Very Low Hazard
Landslides	Moderate Hazard (SE)
Ground Dissolution	No Hazard
Compressible Ground	Moderate Hazard (NE)
Collapsible Deposits	Very Low Hazard
Running Sand	Low Hazard
Radon	Low Hazard (<1% affected)

The moderate compressible ground hazard is likely associated with the presence of soft alluvial clays which underlie the eastern portion of the site in proximity to the River Irk.

The landslide hazard is associated with a steep embankment adjacent to the SE boundary

4.3 Coal Mining

The Coal Authority operates a risk based approach to the assessment of potential instability issues associated with future development of land located within the pre-defined Coal Authority Consultation Areas. This risk based approach sub-divides the potential risk into 'Low & High' Risk Categories.

To determine the initial risk classification of the proposed development site, a search of the Coal Authority Gazetteer (<http://mapapps2.bgs.ac.uk/coalauthority/home.html>) has been undertaken to assess the locality of the proposed development in relation to known or potential areas of mining risk.

The results of this search confirmed that the proposed development site is located within an area deemed to be at Low Risk from historic mine workings therefore no further assessment is required.

4.4 Hydrology

Surface water features within 250m of the subject site are as follows:

SURFACE WATER FEATURE	QUALITY*	DISTANCE (m)	DIRECTION
River Irk	Poor	Adjacent	North / East
Angling Pond	N/A	<5m	West
Hill Top Reservoir	N/A	100m	Northeast

The southeast sector of the site is located in a currently defined Flood Risk Zone 3; defined as land having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. The remaining area falls within a FRZ 1 and as such is considered to be unaffected by flooding from rivers.

In addition, the Envirocheck report confirms the site to have a potential for groundwater flooding of property situated below ground level to occur.

4.5 Radon Risk Potential

The Envirocheck Report indicates the site is situated in an area where less than 1% of homes are above the Action Level and the BGS reports that no radon protective measures are required in the construction of new dwellings or extensions.

4.6 Industrial Land Uses

The site is located within a predominantly residential area, and as such there is only one Trade Directory entry within a 250m radius; which related to Frank Preston textile manufacturing located on-site; however this entry is no longer active.

There are three Fuel Station entries within a 2.0km radius of the study site; as detailed below:

-  Crumpsall Service Station – Middleton Road (446m NW) – **Open**;
-  Heaton Park Service Station – Middleton Road (558m N) – **Obsolete**;
-  Halfway House Garage - 2 Middleton Road (838m SW) – **Open**.

4.7 Hazardous Substance Consents

The Envirocheck Report confirmed the complete absence of the following Hazardous Land uses within 1000m of the subject site that could potentially prohibit a future residential land use:

-  Control of Major Accident Hazards Sites (COMAH)
-  Explosive Sites
-  Notification of Installations Handling Hazardous Substances (NIHHS)
-  Planning Hazardous Substance Consents
-  Planning Hazardous Substance Enforcements

4.8 Sensitive Land Uses

The closest residential properties are located c. 30m southeast of the site boundary, however these dwellings lie c. 15m above the site level and are not considered a sensitive receptor. The River Irk which forms the northern and eastern site boundary is considered a critical receptor.

No other environmentally sensitive land uses have been identified within 250m of the site.

4.9 Site Sensitivity Assessment

The site is assessed to be located within a **Moderate** sensitivity setting as discussed within Table 4.1 below.

Table 4.1 Site Sensitivity Assessment

SENSITIVITY PROFILE	DISCUSSION	RATING
Sensitive land uses within close proximity (e.g. residential, school, nursery, local nature reserves etc.)	Residential properties are located in close proximity (<30m) to the south, however these dwellings are located c. 15m higher in elevation than the study site and are not considered a sensitive receptor.	Low
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The study site is not located within a Groundwater Source Protection Zone or Drinking Water Safeguard Zone.	Low
Distance to the closest groundwater abstraction point.	There are no potable groundwater abstraction boreholes for public water supply within a 1km radius. An abstraction borehole for general industrial cooling is located 469m east of the site.	Low
Aquifer Classification in Superficial Drift Deposits.	The superficial deposits are not considered a sensitive receptor in this instance due to the industrial nature of the site.	Low
Aquifer classification in Bedrock.	The Principal Aquifer is considered a highly sensitive receptor. However, the overall sensitivity is reduced given the absence of any potable groundwater abstractions within close proximity.	Moderate
Is the site underlain by low permeability Drift to depths in excess of 10.0m?	The site is predominantly underlain by permeable alluvial deposits of sand and gravel.	Moderate
Is the site located within 50m of a watercourse?	The River Irk is located immediately adjacent to the north and eastern boundary of the site.	High
Overall Site Environmental Sensitivity		Moderate

4.10 Preliminary Geotechnical Assessment

The following potential geotechnical constraints have been identified at the site:

-  The site is likely underlain by a variable horizon of Made Ground associated with a number of small in-filled reservoirs and historic construction and demolition activities,
-  Relict foundations / below ground obstructions are likely to be present underlying the former industrial structures;
-  Due to the significant elevation changes across the site (including a former reservoir) a programme of cut / fill works will be required to form a graded development platform;
-  The underlying superficial geology is likely to comprise a predominantly granular soil matrix which may offer the required degree of permeability to facilitate soak-away drainage. However, the close proximity of the River Irk should be considered;
-  There are a number of trees located around the periphery of the site which will mean that in cohesive drift deposits, plot footings will require deepening in accordance with NHBC guidance 2016 Chapter 4.2; and
-  A full and detailed assessment of the potential risk associated with compressible ground will be required to determine what, if any specialist re-enforcement to structural foundations is required in the construction of new structures.

4.11 Unexploded Ordnance

The regional unexploded bomb risk map from Zetica indicates that the site is an area of Lancashire (historic) considered to be at Moderate from possible Unexploded Ordnance (UXO) resulting from Second World War air-delivered ordnance.

However, historical maps do not record any blast damage (or ruins) and the site was partly redeveloped prior to 1992 which would likely have remediated any identified UXO. As such, E3P consider there to be a low risk from UXO at the site.

5. CONSULTATIONS

5.1 Local Authority Contaminated Land Officer

E3P has submitted an enquiry with the Contaminated Land Officer at Manchester City Council regarding potential contaminated land issues / development constraints and a response is awaited.

Any pertinent information received in due course will be issued as an addendum to this report.

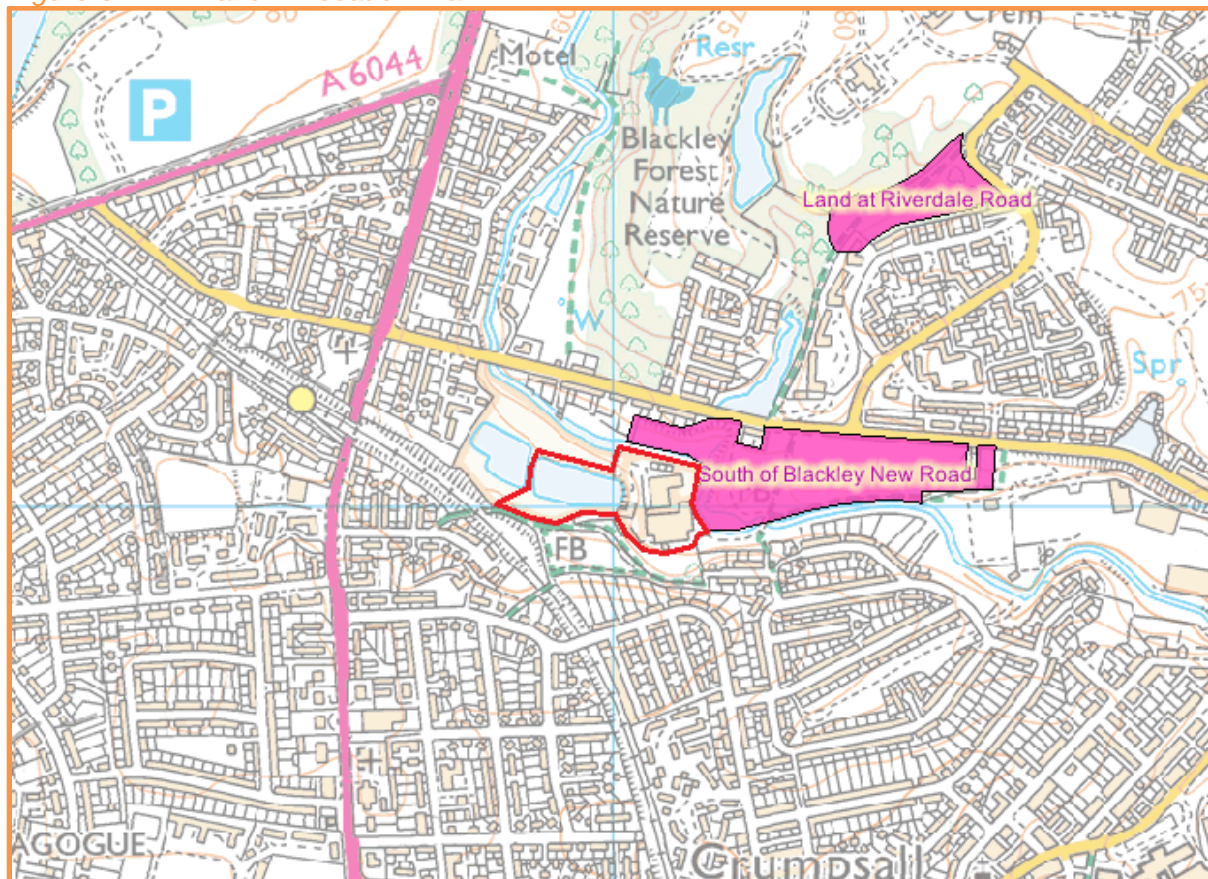
5.2 Landfill Sites and Waste Treatment Sites

No waste treatment facilities are recorded within a 250m radius of the application site.

However, a historic landfill site (South of Blackley New Road) is located adjacent to the site (opposite side of the River Irk) as presented in the snapshot Figure 5.1 below.

No details of the waste materials tipped or activity period has been provided.

Figure 5.1 Landfill Location Plan



The approximate site boundary is denoted in red.

5.3 Regulatory Database

The following information has been obtained from a commercially available environmental database. The summary table (only includes records not otherwise detailed in the report.

ENTRY	NUMBER WITHIN 250M RADIUS	DETAILS
Contaminated Land Register Entries and Notices	0	Not Applicable (N/A).
Authorised industrial processes (IPC/IPPC/LAPPC).	0	N/A.
Fuel Stations Entries	0	See Section 4.6.
Licensed radioactive substances	0	N/A.
Enforcements, prohibitions or prosecutions	0	N/A.
Discharge Consents	0	N/A.
Pollution Incidents	13	The entries relate to incidents of minor severity (7 No. on site and 6 No. within 250m) and are not considered to pose a contaminative risk to future site users.
Consents issued under the Planning (Hazardous Substances) Act 1990	0	N/A.
Control of Major Accident Hazard (COMAH) sites	0	N/A.

6. INITIAL CONCEPTUAL SITE MODEL

6.1 Initial CSM

In accordance with Environment Agency, CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), E3P Ltd have developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area.

SOURCE	EXPOSURE	POTENTIAL PATHWAY
Human Health		
Heavy Metals and Non-volatile PAHs	Dermal Contact and Ingestion Consumption of Homegrown Produce	Construction Workers Residential End Users
Discussion: The presence of Made Ground associated with in-filled reservoirs and historic construction / demolition activities may be a low level source of Polycyclic Aromatic Hydrocarbon (PAH), hydrocarbon compounds and heavy metals. If present, the above constituents may pose a short term risk to construction workers and future residential site users may come into contact with impacted soils within any garden and landscaped areas.		
Sodium Hypochlorite / Mercury	Dermal Contact and Ingestion Consumption of Homegrown Produce Vapour Inhalation	Construction Workers Residential End Users
Discussion: Sodium hypochlorite is diluted with water with the addition of detergents or soap to make bleach or disinfectant. No hazardous materials storage was observed during the walkover, however given the historic use of the site it is considered likely that a sodium hypochlorite solution (bleach) was stored in the bleach works. Any in-filled bleach pits and historic above ground storage tanks located at the site are a potential source of bleach solution, although this is thought to be a very low risk as it is likely the tanks were pumped dry and cleaned prior to backfilling or removed entirely when the site was redeveloped.		
Hydrocarbon Compounds	Volatilisation / Accumulation Vapour Inhalation	Construction Workers Residential End Users
Discussion: The presence of historic ASTs suggests fuel / engine oils may have been stored at the site and could have resulted in minor spillages which may give rise to localised hydrocarbon impact to shallow soils. Furthermore, the site was previously used as a print works, bleach and dye works and more recently a textile works, and as such the use of machinery would indicate that lubricating oils would have been present on site. However, due to the presence of substantial concrete slabs the potential risk of lubricating oils impacting the underlying ground is considered to be low to moderate. Volatile hydrocarbon compounds, SVOC and VOC associated with the storage of fuel / engine oils pose a potential risk of volatilisation and accumulation to indoor air spaces.		

SOURCE	EXPOSURE	POTENTIAL PATHWAY
Asbestos Containing Materials (ACM)	Fibre / Dust Inhalation	Construction Workers Residential End Users Third Party Property
Discussion: Due to the age and nature of the former industrial structures at the site, the presence of ACM within the underlying Made Ground cannot be discounted. A pre-demolition asbestos survey should be completed within the remaining structures to confirm the presence of any ACM, with subsequent controlled removal by a specialist contractor prior to demolition. ACM poses a risk through fibre and dust inhalation and if present may pose a risk to construction workers during any future earthworks / demolition and to adjacent third party property should dust be generated during those works.		
Polychlorinated Biphenyls (PCBs)	Dermal Contact and Ingestion	Construction Workers Commercial End Users
Discussion: An active electrical substation is located in the south-central sector of the site, adjacent to the former site office. Historical mapping indicates this substation was likely constructed prior to the 1970s, and as such, may potentially have contained PCBs. If encountered, localised remediation will be required to ensure no unacceptable degree of risk to future residential site users.		
Hazardous Ground Gases from Made Ground	Vapour Inhalation Volatilisation to Indoor Air	Construction Workers, Residential End Users
Discussion: Made Ground associated with historic construction and demolition activities and potential hydrocarbon impact (associated with ASTs) to shallow soils may be a potential source of low-level hazardous ground gas which can accumulate within deep excavations or migrate through permeable strata, foundation structures and/or service ducting and pose a potential risk to construction workers and future residential site users. South Blackley historical landfill is recorded on the opposite side of the river, however the presence of the alluvial channel will act to have limited excavation depths in this area to below that of the river and as such the potential for gaseous continuity with the subject site is low.		
Controlled Waters		
Mobile Contaminants	Vertical / Lateral Migration	River Irk Principal Aquifer
Discussion: As discussed above the Made Ground beneath the site may contain residual hydrocarbon and volatile organic compound impact associated with the presence of oil storage tanks. The underlying bedrock aquifer is not deemed to be a sensitive receptor in this instance, given the absence of any potable water supply infrastructure (abstraction boreholes) within proximity (<1km) to the site. However, the River Irk lies downgradient immediately adjacent to the north and east of the site, which is considered to be a critical receptor, in this instance. In addition, the site is predominantly underlain by granular soils within the eastern sector, as such the potential for lateral migration of impacted groundwater is considered to pose a moderate risk to surface water.		
Buildings and Infrastructure		
pH & Sulphate	Corrosion of Concrete	Foundation / Concrete
Discussion: Assessment must be undertaken to confirm the levels of pH and sulphate within the underlying strata and in particular any Made Ground deposits so that a concrete classification can be determined.		

SOURCE	EXPOSURE	POTENTIAL PATHWAY
Ecology		
Hydrocarbon Compounds	Migration to nearby surface watercourse.	River Irk
Discussion: The potential for any mobile phase contamination to migrate laterally into the River Irk may pose an unacceptable level of risk to ecology and aquatic ecosystems.		

7. INTRUSIVE GROUND INVESTIGATION

7.1 General Overview

A Ground Investigation (GI) was completed between the 17th and 18th August 2016, and has been designed based on the requirement of the proposed residential development.

The GI consisted of advancing 12 No. Window Sample Probeholes and 25 mechanically excavated Trial Pits to collect geotechnical information to assist in the design and construction of the development, provide information on baseline conditions and target potential contaminant sources as summarised in Table 7.1.

Table 7.1 Summary of Fieldwork

POTENTIAL SOURCE/RATIONALE	LOCATION HOLE	TYPE	MAXIMUM DEPTH (mbgl)	MONITORING WELLS RESPONSE ZONE (mbgl)
Former reservoir in SE sector.	WS101	Window Sample Probehole	5.45	N/A
Historic ASTs in south	WS102		3.45	0.50-1.00
Adjacent to the River Irk.	WS103		3.45	1.00-3.00
	WS104		5.45	1.00-4.00
Former reservoir in NE sector.	WS105		3.45	0.50-2.00
Adjacent to the River Irk.	WS106		3.45	1.50-2.50
Adjacent to reservoir in west.	WS107		5.45	1.00-4.00
	WS108		5.45	N/A
Former Bleach / Dye Works.	WS109		5.45	1.00-3.00
	WS110		5.45	1.00-4.00
	WS111		5.45	N/A
	WS112		3.45	1.00-2.00
Investigation of general ground conditions, depth of Made Ground, nature of below ground obstructions, geotechnical information, collection of environmental samples.	TP101-TP125	Mechanically Excavated Trial Pit	2.90	N/A

The sampling locations are illustrated in Drawing 11-164-003 (Appendix III). The ground conditions encountered are indicated on the logs which are provided in Appendix VI.

Return visits were made to monitor installations for gas concentrations, groundwater level and collect groundwater samples.

7.2 In-Situ Standard Penetration Testing (SPT)

In-situ geotechnical testing was conducted using the Standard Penetration Test (SPT).

The results are shown in the probehole logs in Appendix VI and presented in Table 8.2 and discussed in Section 10.4.

7.3 Laboratory Analysis

Selected soil and groundwater samples were submitted to i2 Analytical Laboratory for a range of chemical analysis comprising:

-  Metals, cyanide, pH, total sulphate, water soluble sulphate, sulphide; phenols;
-  Asbestos;
-  Total and speciated poly-aromatic hydrocarbons (PAHs); and
-  Total and speciated petroleum hydrocarbon (TPH).

Selected samples were submitted to i2 Analytical Laboratory where the following geotechnical tests were undertaken:

-  Atterberg Limits Determinations; and
-  Moisture Content.

Laboratory analysis results are presented in Appendix VIII and summarised in Section 8.1.8.

8. GROUND AND GROUNDWATER CONDITIONS

8.1 Ground and Groundwater Conditions

8.1.1 Summary of Ground Conditions

The Ground Investigation generally confirms the published geology and identifies the strata set out in Table 8.1 below:

Table 8.1 Summary of Strata

STRATA	GENERAL DESCRIPTION	TYPICAL DEPTH (mbgl):				LOCATION
		TOP:		BASE:		
		MIN:	MAX:	MIN:	MAX:	
Made Ground						
Asphalt	MG: Asphalt.	GL	GL	0.07	0.10	TP101, 111, 125, WS111
Concrete	MG: Concrete.	GL	0.10	0.20	0.35	TP101, 105, 109,121-123, 125, WS112
Silty Gravel	MG: Black sandy silty gravel. Gravel is fine to coarse angular to sub-angular of concrete, brick, mudstone, sandstone, slate, plastic, timber and metal. Cobbles of brick / concrete.	GL	2.00	0.50	2.70	TP101-111, 113, 115,117, 119,120,121, 123, 124 WS101, 103-111
Gravelly Clay	MG: Dark brown sandy gravelly clay. Gravel is fine to coarse angular to sub-angular of concrete, brick, mudstone, sandstone, coal.	GL	0.65	0.95	1.80	TP112, 116, 118 WS101
Sandy Clay	MG: Brown sandy clay (reworked).	0.50	1.00	1.20	1.50	TP105, 120
Silty Sand	MG: Black / brown silty fine to coarse sand (reworked). Cobbles of brick and concrete.	0.50	2.10	1.00	3.00	TP101,108, 113 WS105, 112
Gravel	Red / white gravel. Gravel is fine to coarse angular to sub-angular of brick.	1.00	1.80	1.30	2.30	TP111-1112 WS106, 112
Sandy Gravel	MG: Brown / grey / black sandy gravel. Gravel is fine to coarse angular to sub-angular of sandstone, slate, brick, ash, concrete, mudstone and mixed lithology.	GL	3.00	0.05	3.45	TP101,111, 113,117-118, 120,122, 125 WS101-WS108, 110-112
Natural Strata						
Sandy SILT	Very loose to loose brown / grey slightly gravelly and/or sandy SILT.	GL	2.90	0.25	3.45	TP107, 114 WS101-105, 107,110-111
Silty / Gravelly SAND	Very loose to medium dense brown / orange silty and/or gravelly fine to coarse SAND.	0.50	3.10	1.80	5.45	TP104-108, 116-117, 121-123 WS101, 103-104, 106, 108-109, 111
Gravelly CLAY	Stiff to very stiff medium to high strength brown sandy and/or gravelly CLAY.	0.25	4.90	1.00	5.45	TP106, 114, 118, 120 WS101, 107-110,

8.1.2 Topsoil

A 250mm horizon of gravelly SILT (Topsoil) was encountered at TP114.

The topsoil was generally free of any deleterious element or visual contaminants.

8.1.3 Made Ground

Made Ground was encountered within all exploratory locations to a maximum proven depth of 3.45m bgl (WS112) underlying the former bleach work, although generally to depth in excess of 1.0m bgl across the wider site.

Made Ground deposits were generally uniform and comprised a silty and/or sandy gravel of concrete, brick, ash, mudstone, sandstone, slate, plastic, timber and metal believed to be associated with historic fill material resulting from construction and demolition activities. Localised discontinuous sandy and/or gravelly clay soils and reworked sand were recorded.

Deeper Made Ground (~2.90m bgl) was at WS105 associated with an in-filled reservoir.

A hydrocarbon odour was noted at five locations (TP101-TP104 & TP106) across the southeast portion of the site all of which lie downgradient of the former ASTs. The impact was noted within both the Made Ground and underlying natural granular soils.

In addition, an organic / chemical odour was noted at a number of location predominantly underlying the historic (since demolished) bleach works. The odours are likely associated with the storage and use of chemicals (including sodium hypochlorite) and detergents / solvents to produce bleach or disinfectant as part of the bleaching and dyeing process.

A Depth of Made Ground Plan (Drawing No. 11-164-006) is presented in Appendix III.

8.1.4 Drift Deposits

Drift deposits were encountered within all exploratory hole locations where the Made Ground could be fully penetrated to a proven depth of 5.45m bgl.

The superficial glacial soil deposits generally comprised a silty and/gravelly very loose to medium dense SAND with localised areas of very loose to loose sandy SILT within the eastern portion in close proximity to the River Irk.

A number of stiff to very stiff medium to high strength gravelly CLAY bands were recorded underlying the Made Ground soils, typically across the central portion of the site.

8.1.5 Solid Geology

No solid geology was encountered as part of the intrusive site investigation.

8.1.6 Soil Consistency

Results of the Standard Penetration Tests, including undrained shear strengths derived from SPTs are included on Table 8.2 (overleaf).

Consideration must be made to the granular content of the glacial soils which can lead to misrepresentative results.

8.1.7 Side Stability and Ease of Excavation

The sides of the exploratory trial pit excavations appeared to be generally unstable during excavation due to the predominantly granular nature of the Made Ground and underlying natural soils.

A relict foundation was encountered at 1.10m bgl in TP124 and the presence of further below ground obstructions cannot be discounted. Any previously unidentified sub-structures will need to be removed in their entirety as part of the proposed redevelopment.

The natural glacial soils were penetrated with relative ease and future excavation activities should be feasible with normal plant.

Table 8.2 Standard/Cone Penetration Test Results

Boreholes	Depth (m bgl)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil Strength	Consistency (BS5930)	Terzaghi & Peck Approximate Undrained Shear Strength (kN/m ²)
WS101	2	Gravelly SILT	2	1.83	Very Loose	N/A	N/A	N/A
	3	Silty SAND	6	5.22	Loose	N/A	N/A	N/A
	4	Silty SAND	11	9.29	Loose	N/A	N/A	N/A
	5	Gravelly CLAY	14	20.74	N/A	High Strength	Very Stiff	103.70
WS103	1	Gravelly SILT	1	1.01	Very Loose	N/A	N/A	N/A
	2	Silty SAND	1	0.91	Very Loose	N/A	N/A	N/A
	3	Silty SAND	4	3.48	Very Loose	N/A	N/A	N/A
	4	Silty SAND	7	5.91	Loose	N/A	N/A	N/A
	5	Gravelly CLAY	35	29.04	N/A	High Strength	Very Stiff	145.18
WS104	2	Sandy SILT	2	1.83	Very Loose	N/A	N/A	N/A
	3	Silty SAND	5	4.35	Loose	N/A	N/A	N/A
	4	Silty SAND	10	8.45	Loose	N/A	N/A	N/A
	5	Silty SAND	15	12.44	Medium Dense	N/A	N/A	N/A
WS105	3	Sandy SILT	9	7.83	Loose	N/A	N/A	N/A
WS106	2	Gravelly SAND	18	16.44	Medium Dense	N/A	N/A	N/A
	3	Gravelly SAND	27	23.48	Medium Dense	N/A	N/A	N/A
	4	Gravelly SAND	36	30.41	Dense	N/A	N/A	N/A

Boreholes	Depth (m bgl)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil Strength	Consistency (BS5930)	Terzaghi & Peck Approximate Undrained Shear Strength (kN/m ²)
WS107	2	Sandy SILT	3	2.74	Very Loose	N/A	N/A	N/A
	3	Gravelly CLAY	13	11.31	N/A	Medium Strength	Stiff	56.53
	4	SAND	11	9.29	Loose	N/A	N/A	N/A
	5	SAND	7	5.81	Loose	N/A	N/A	N/A
WS108	2	Gravelly CLAY	14	12.79	N/A	Medium Strength	Stiff	63.95
	3	SAND	17	14.78	Medium Dense	N/A	N/A	N/A
	4	SAND	17	14.36	Medium Dense	N/A	N/A	N/A
	5	SAND	22	18.25	Medium Dense	N/A	N/A	N/A
WS109	1	Silty SAND	2	2.02	Very Loose	N/A	N/A	N/A
	2	Silty SAND	8	7.31	Loose	N/A	N/A	N/A
	3	Gravelly SAND	13	11.31	Medium Dense	N/A	N/A	N/A
	4	Sandy CLAY	29	24.50	N/A	High Strength	Very Stiff	122.50
	5	Sandy CLAY	18	14.93	N/A	Medium Strength	Stiff	74.67
WS110	2	Gravelly CLAY	15	13.70	N/A	Medium Strength	Stiff	68.52
	3	Gravelly CLAY	21	18.26	N/A	High Strength	Very Stiff	91.31
	4	Gravelly CLAY	12	10.14	N/A	Medium Strength	Stiff	50.69
	5	Gravelly CLAY	13	10.79	N/A	Medium Strength	Stiff	53.93

Boreholes	Depth (m bgl)	Material Field Description	CPT/SPT "N" Value	Corrected "N" Value (N ₁) ₆₀	Terzaghi & Peck Relative Density (Sands)	Eurocode Soil Strength	Consistency (BS5930)	Terzaghi & Peck Approximate Undrained Shear Strength (kN/m ²)
WS111	2	Sandy SILT	7	6.39	Loose	N/A	N/A	N/A
	3	Sandy SILT	6	5.22	Loose	N/A	N/A	N/A
	4	Sandy SILT	7	5.91	Loose	N/A	N/A	N/A
	5	Sandy SILT	6	4.98	Loose	N/A	N/A	N/A

8.1.8 Soil Plasticity

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each “type” of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth.

E3P typically only consider a soil to be shrinkable if the proportion finer than 63µm is >35%.

PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised January 2014), which advocates the use of modified Plasticity Index (I_p), defined as:

$$I'_p = I_p * (\% < 425\mu\text{m} / 100)$$

ie if PI is 30%, but the soil contains 80% < 425µm, then: $I'_p = 30 * 80/100 = 24\%$.

It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs.

E3P apply engineering judgment where PI results are spread over a range of classifications. Consideration is given to the average values for each particular soil type (ie differentiate between residual soil and alluvium), the number of results in each class and the actual values.

The Atterberg Limits determinations, summarised in Table 8.3 below, show the clay to be of Low Plasticity and therefore Low Volume Change Potential.

Table 8.3 Summary of Plasticity Index Test Results

LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	PERCENTAGE PASSING 425MM SIEVE (%)	MODIFIED PLASTICITY INDEX
WS108	2.00	16	20	34	14	95	13.3
WS110	3.00	22	15	21	6	96	5.76
TP118	1.60	16	16	22	6	94	5.64

8.1.9 Soil Infiltration

Falling head permeability tests were not undertaken as part this report due to the potential for hydrocarbon impact to shallow soils.

8.1.10 pH and Sulphate

Chemical analyses for pH and soluble sulphate content contained in Appendix VII (summarised below in Table 8.4), shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE Special Digest 1 (2005).

Table 8.4 Summary of pH and Sulphate Data

LOCATION	DEPTH (m)	SO ₄ IN 2:1 WATER / SOIL (g/l)	pH VALUE	CLASSIFICATION
WS101	1.90	0.13	8.0	DS-1 AC-1s
WS106	0.90	0.067	8.5	DS-1 AC-1s
WS107	1.80	0.034	8.1	DS-1 AC-1s
WS108	1.90	0.024	8.0	DS-1 AC-1s
WS109	1.10	0.013	8.4	DS-1 AC-1s
WS110	0.80	0.030	8.7	DS-1 AC-1s
WS111	1.95	0.25	7.6	DS-1 AC-1s
TP101	0.40	0.16	8.5	DS-1 AC-1s
TP103	0.40	0.066	8.2	DS-1 AC-1s
TP104	0.30	0.034	8.0	DS-1 AC-1s
TP101	1.20	0.0091	8.2	DS-1 AC-1s
TP105	0.50	1.8	8.7	DS-2 AC-2s
TP106	2.00	0.065	7.6	DS-1 AC-1s
TP107	0.80	0.051	8.2	DS-1 AC-1s
TP109	1.10	0.11	8.2	DS-1 AC-1s
TP115	0.90	1.6	8.4	DS-2 AC-2s
TP117	0.30	0.27	7.4	DS-1 AC-1s
TP118	1.40	0.15	8.4	DS-1 AC-1s

Based on the results of the analysis, the ground conditions across the site do not appear to pose a significant risk to buried concrete. Furthermore, it is anticipated that following a phase of remediation and enabling works, the soils will meet class DS-1 and AC-1s.

8.2 Groundwater Conditions

A number of groundwater strikes / seepages were noted at depths of between 0.50-4.00m bgl.

Furthermore, subsequent monitoring indicates the presence of shallow groundwater generally at depths of between 0.50-3.50m bgl. Groundwater was shallower in proximity to the River Irk.

8.3 Ground Gas

Concentrations of methane (CH₄), carbon dioxide (CO₂) and Oxygen (O₂) were measured using an infra-red gas analyser (GFM435) with flow rates measures on an integrated flow meter.

Gas measurements were recorded for a minimum of sixty seconds at each location, at which point the maximum concentration of CH₄ and CO₂ together with the lowest concentration of O₂ were recorded. The results of the ground gas monitoring are presented in Table 8.5 (overleaf).



Table 8.5 Summary of Ground Gas and Groundwater Monitoring

Well	Date	CH ₄ Initial %v/v	CH ₄ Steady %v/v	CH ₄ GSV l/hr	CO ₂ Initial %v/v	CO ₂ Steady %v/v	CO ₂ GSV l/hr	O ₂ %v/v	Atmos (mb)	Atmos. Dynamic	Flow (l/hr)	Depth to Base (mbgl)	Depth to Water (mbgl)
WS101	25/08/16	0.1	0.1	0.00098	0.9	0.9	0.00882	17.6	1012	Falling	0.98	3.16	0.5
	23/09/16	0.1	0.1	-0.00776	0.4	0.3	-0.03104	20.3	1018	Steady	-7.76	2.94	0.54
WS102	25/08/16	0.1	0.1	-0.00164	4.0	4.0	-0.0656	15.6	1012	Falling	-1.64	1.0	1.0
	23/09/16	0.1	0.1	-0.00403	3.3	3.3	-0.13299	15.7	1018	Steady	-4.03	1.0	1.0
WS103	25/08/16	0.1	0.1	0.00558	0.7	0.7	0.03906	17.7	1012	Falling	5.58	1.85	0.26
	23/09/16	0.1	0.1	0.0001	0.4	0.4	0.0004	19.9	1018	Steady	0.1	1.76	0.5
WS104	25/08/16	0.1	0.1	-0.00026	5.9	5.9	-0.01534	13.1	1012	Falling	-0.26	3.5	2.33
	23/09/16	0.1	0.1	-0.00052	5.8	5.8	-0.03016	12.6	1018	Steady	-0.52	3.46	2.5
WS105	25/08/16	0.1	0.1	0.00079	2.8	2.8	0.02212	14.5	1012	Falling	0.79	1.92	Dry
	23/09/16	0.1	0.1	-0.00026	2.3	2.3	-0.00598	17.9	1018	Steady	-0.26	2.0	Dry
WS106	25/08/16	0.1	0.1	-0.00379	5.5	5.5	-0.20845	12.8	1012	Falling	-3.79	2.45	2.45
	23/09/16	0.1	0.1	-0.00204	4.6	4.6	-0.09384	15.2	1018	Steady	-2.04	2.45	Dry
WS107	25/08/16	No access.											
	23/09/16	0.1	0.1	-0.00144	5.5	5.5	-0.0792	13.2	1018	Steady	-1.44	4.02	3.4
WS109	25/08/16	0.1	0.1	-0.00266	4.1	4.1	-0.10906	16	1012	Falling	-2.66	3.03	1.77
	23/09/16	0.1	0.1	-0.00013	2.7	2.7	-0.00351	17.8	1018	Steady	-0.13	3.0	1.97
WS110	25/08/16	0.1	0.1	0.0001	1.0	1.0	0.001	17.3	1012	Falling	0.1	4.04	1.0
	23/09/16	0.1	0.1	-0.00204	0.5	0.5	-0.0102	19.6	1018	Steady	-2.04	4.04	1.03
WS111	25/08/16	0.1	0.1	-0.00149	0.1	0	-0.00149	20.2	1012	Falling	-1.49	1.75	0.6
	23/09/16	0.1	0.1	0.00052	0.1	0.1	0.00052	20.2	1018	Steady	0.52	1.63	0.75

9. TIER I QUALITATIVE CONTAMINATED LAND RISK ASSESSMENT

E3P has undertaken a Tier 1 qualitative risk assessment to determine if any potential contaminants within the underlying soils and groundwater pose an unacceptable level of risk to the identified receptors.

9.1 Human Health Risk Assessment

At a Tier 1 stage the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference to Generic Assessment Criteria (GACs) values published by LQM / CIEH 2nd edition - Suitable 4 Use Levels (S4UL), DEFRA - Category 4 Screening Levels (C4SL), and EA - Contaminated Land Exposure Assessment (CLEA), Soil Guideline Values (SGV).

The results of this comparison have been summarised within Table 9.1 (overleaf).

Table 9.1 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX(m)	STRATA	PATHWAY	ASSESSMENT
Arsenic	mg/kg	37	18	77 170 330 73 85 45 56 3300	TP101-0.40 TP103-0.40 TP104-0.30 TP105-0.50 TP107-0.80 TP115-0.90 TP117-0.30 WS106-0.90	MG MG MG MG MG MG MG MG	1	Further Assessment
Cadmium	mg/kg	17	18	4.3	N/A	N/A	1	No Further Action
Chromium (VI)	mg/kg	6.1	18	<4.0	N/A	N/A	1	No Further Action
Lead	mg/kg	200	18	280 870 500 270 430 510 220 220 710 360	TP101-0.40 TP103-0.40 TP104-0.30 TP105-0.50 TP107-0.80 TP109-1.10 TP115-0.90 TP117-0.30 WS106-0.90 WS110-0.80	MG MG MG MG MG MG MG MG MG MG	1	Further Assessment
Mercury	mg/kg	11	18	3.3	N/A	N/A	2	No Further Action
Nickel	mg/kg	180	18	60	N/A	N/A	1	No Further Action
Selenium	mg/kg	250	18	2.0	N/A	N/A	1	No Further Action
Copper	mg/kg	2400	18	630	N/A	N/A	1	No Further Action
Zinc	mg/kg	3700	18	1400	N/A	N/A	1	No Further Action
Cyanide - Total	mg/kg	791	18	3	N/A	N/A	1	No Further Action
Phenols - Total.	mg/kg	210	18	<1.0	N/A	N/A	1	No Further Action
Asbestos	Fibres	NFD	18	FD	TP101-0.40 TP105-0.50 TP107-0.80 TP109-1.10 TP115-0.90 TP117-0.30 WS106-0.90	MG MG MG MG MG MG MG	4	Further Assessment
Naphthalene	mg/kg	2.3	18	1.0	N/A	N/A	2	No Further Action
Acenaphthylene	mg/kg	170	18	0.31	N/A	N/A	3	No Further Action
Acenaphthene	mg/kg	210	18	<0.10	N/A	N/A	1	No Further Action
Fluorene	mg/kg	170	18	0.32	N/A	N/A	1	No Further Action
Phenanthrene	mg/kg	95	18	3.3	N/A	N/A	3	No Further Action
Anthracene	mg/kg	2400	18	0.59	N/A	N/A	3	No Further Action
Fluoranthene	mg/kg	280	18	5.5	N/A	N/A	3	No Further Action
Pyrene	mg/kg	620	18	5.4	N/A	N/A	3	No Further Action
Benzo(a)Anthracene	mg/kg	7.2	18	2.9	N/A	N/A	3	No Further Action
Chrysene	mg/kg	15	18	2.2	N/A	N/A	3	No Further Action
Benzo(b/k)Fluoranthene	mg/kg	2.6	18	4.5	TP105-0.50	MG	3	Further Assessment
Benzo(a)Pyrene**	mg/kg	77	18	3.0	N/A	N/A	3	No Further Action
Indeno(123-cd)Pyrene	mg/kg	2.2	18	1.3	N/A	N/A	3	No Further Action
Dibenzo(a,h)Anthracene	mg/kg	27	18	0.30	N/A	N/A	3	No Further Action
Benzo(ghi)Perylene	mg/kg	0.24	18	0.64 1.7 1.2 0.75 0.64 0.75	TP101-0.40 TP105-0.50 TP107-0.80 TP109-1.10 WS106-0.90 WS107-1.80	MG MG MG MG MG MG	3	Further Assessment

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX(m)	STRATA	PATHWAY	ASSESSMENT
TPH C5-C6 (aliphatic)*	mg/kg	320	18	<1.0	N/A	N/A	2	No Further Action
TPH C6-C8 (aliphatic)*	mg/kg	42	18	<0.1	N/A	N/A	2	No Further Action
TPH C8-C10 (aliphatic)*	mg/kg	100	18	<0.1	N/A	N/A	2	No Further Action
TPH C10-C12 (aromatic)*	mg/kg	27	18	<2.0	N/A	N/A	2	No Further Action
TPH C12-C16 (aromatic)*	mg/kg	74	18	15	N/A	N/A	2	No Further Action
TPH C16-C21 (aromatic)*	mg/kg	140	18	74	N/A	N/A	1	No Further Action
TPH C21-C35 (aromatic)*	mg/kg	260	18	320	TP115-0.90	MG	1	Further Assessment

Notes

Main Exposure Pathways: 1 = Soil Ingestion, 2 = Vapour Inhalation (indoor), 3 = Dermal Contact & Ingestion, 4 = Dust Inhalation.
Abbreviations: GAC = General Assessment Criteria, n = number of samples, MC = Maximum Concentration; Loc of Ex = Location of Exceedance; NFD = No Fibres Detected

* The Tier 1 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. E3P has utilised the Tier 1 values for aliphatic compounds for the volatile and semi volatile fractions (C₅-C₁₂) and the Tier 1 values for aromatic compound for the non-volatile fractions (C₁₂-C₃₅). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

Referring to Table 9.1, the results of this direct comparison indicates that the data exceeds the screening criteria for a residential end use for the following contaminants:

-  Arsenic
-  Lead
-  Benzo(b/k)Fluoranthene
-  Benzo(ghi)Perylene;
-  Hydrocarbon Fractions C21-C35 (aromatic)
-  Asbestos

Asbestos in the form of amosite, crocidolite and chrysotile have been identified in the Made Ground across the site.

The laboratory analysis confirms the assessment within the initial conceptual site model that the main constituents of concern were likely to be asbestos, PAHs, hydrocarbon compounds and heavy metals.

In relation to these exceedances, the main exposure pathways based on the Tier I exceedances are:

-  Soil Ingestion (Heavy metals & TPH C21-C35);
-  Dermal Contact and Soil Ingestion (PAHs); and,
-  Dust Inhalation (Asbestos).

Risk Assessment and Mitigation

Heavy Metals, PAHs & Non-Volatile TPH

For the elevated concentrations of non-volatile PAHs and TPH compounds the viable exposure pathway is directly related to soil ingestion and/or dermal contact.

These risks can be mitigated through careful management of earthworks so as to prevent impacted soils being exposed to constructions workers through the use of appropriate Personal Protective Equipment (PPE) and provision of welfare facilities.

In garden and landscaped areas which are not covered by plots or hard-standing, a chemically suitable cover system will be required thereby removing the exposure pathway and ensuring no unacceptable degree of risk is posed to future residential site users.

The specific design and installation process for the appropriate cover systems will be clearly defined within the Site Remediation & Enabling Works Strategy, however industry best practice (as outlined within BRE 465) will require the following minimum depths of certified clean cover:

-  Private Gardens where home-grown vegetables can be cultivated – **600mm**
-  Landscaped areas within private dwellings – **300mm**
-  Public Open Space – **300mm**

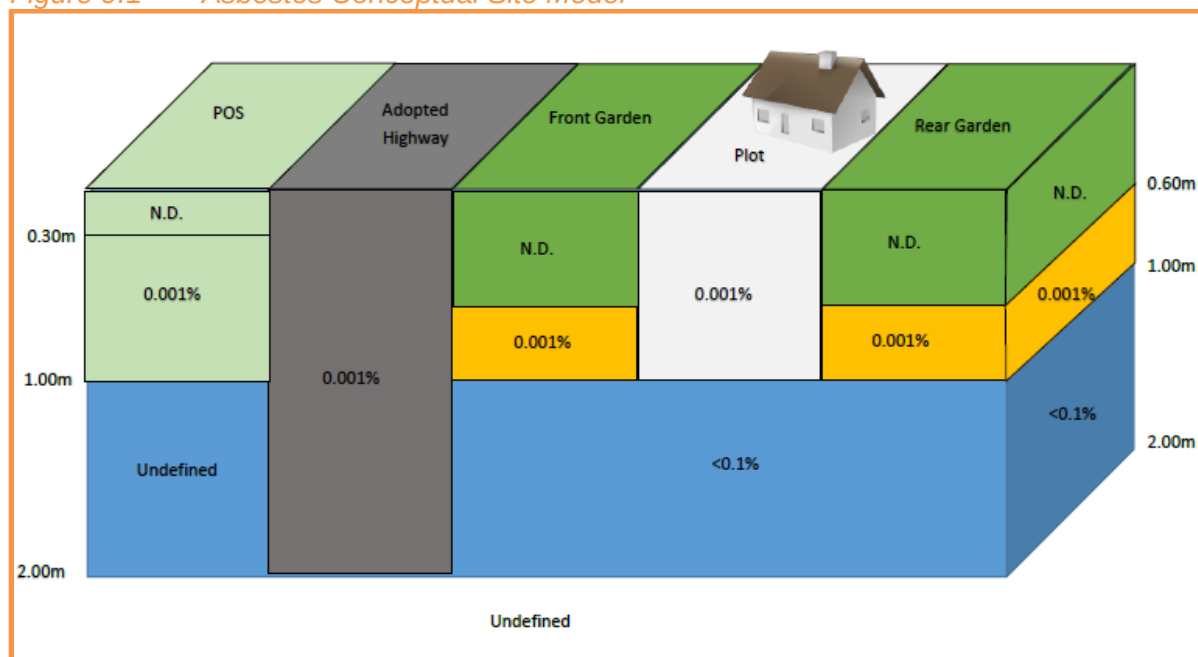
Asbestos

Asbestos has also been identified at a number of location within the shallow Made Ground deposits across the site. Asbestos quantification should be undertaken to further assess where these soils may be placed. No visual signs of ACM were encountered during the Ground Investigation, therefore it is likely only trace fibres are present within these localised soils and a process of hotspot excavation with placement of impacted soils at depth beneath proposed plots may be undertaken to ensure they pose no unacceptable risk to the future site users.

Given the presence of asbestos fibres within the Made Ground, a suitably detailed remediation strategy will be required to document the safe handling, management and placement of all Made Ground so as to ensure that no unacceptable degree of risk is presented to construction workers or future residential site users.

E3P has produced an asbestos specific CSM which identifies the locations that asbestos impacted soils may be placed in a residential setting (in accordance with quantification results) to ensure there is no unacceptable level of risk to the future residential site users. The CSM is presented as Figure 9.1 below:

Figure 9.1 Asbestos Conceptual Site Model



Chemical analysis confirms that the natural underlying drift strata is suitable for use within the development therefore any drift deposits cut within the enabling works, pending confirmatory chemical validation, may be utilised as subsoil within any proposed garden and landscaped areas.

The shallow underlying Made Ground will not be suitable for use as topsoil or subsoil element within any proposed garden or landscaped areas due to the aforementioned impacted soils.

The chemical analysis results did not indicate concentrations of hydrocarbon compounds within the soils, above the relevant GAC. However, historic storage tanks on site are considered to pose a potential risk and the presence of hydrocarbon impact to shallow soils cannot be discounted. A watching brief should be undertaken as part of the Remediation and Enabling Works programme to ensure any previously unidentified contamination is remediated in accordance with industry best practice.

9.2 Controlled Waters Risk Assessment

The site sensitivity with respect to controlled waters is summarised within Table 9.2

Table 9.2 Controlled Waters Sensitivity Profile

Risk Profile	Discussion	Risk Rating & Rationale
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	No	Low
Distance to the closest groundwater extraction point.	469m	Low – The abstraction is for general industrial cooling purposes. There are no potable groundwater abstractions boreholes within a 1km radius of the site.
Aquifer Classification in Superficial Drift Deposits.	Secondary	Low – The superficial aquifer is not considered a sensitive receptor in this instance.
Aquifer Classification in Bedrock.	Secondary A / Principal	Moderate – The Principal Aquifer is a not considered a strategic water resource given the absence of any potable groundwater abstraction licences within the locality.
Viability for Anthropogenic soil in direct contact with Aquifer. (Drift or Bedrock).	Yes	Moderate – Made Ground deposits to depths of up to 3.45m bgl were recorded at the site directly overlying predominantly granular drift soils.
Is the site underlain by low permeability Drift to depths in excess of 10.0m?	No	Moderate – The site is predominantly underlain by granular soils with localised areas of low permeability clay strata.
Is the site located within 50m of a surface watercourse?	Yes	High – The River Irk forms the north and eastern boundary of the site.
Summary The ICSM developed within the context of the site setting has identified a viable pollutant linkage; being the lateral migration of any mobile contaminants from the identified hotspots on-site towards the River Irk which lies immediately downgradient to the north and east of the site. The underlying Principal Aquifer is not considered a critical receptor in this instance given the absence of any potable groundwater abstraction boreholes within close proximity to the site.		

To further refine the ICSM, E3P has undertaken an initial qualitative assessment of the soil data analysis to assess the potential for a source of separate phase or dissolved phase contamination originating from either a defined on-site source or from impacted soils.

This assessment is summarised in Table 9.3.

Table 9.3 Qualitative Risk to Controlled Waters from Soil Analytical Results

BTEX - <1ppm	The soil data analysis has not identified any detectable concentrations of TPH C5 to C6 that might otherwise be indicative of BTEX and/or SVOC / VOC impact
Total VOC - <1ppm	
Total SVOC - <1ppm	
C5-C10 <5ppm	All concentrations are below the laboratory LOD.
C10-C12 <10ppm	Concentrations above 10mg/kg have not been recorded.
C12-C16 <50ppm	Concentrations above 50mg/kg have not been recorded.
Phenols - <2ppm	All concentrations are below the laboratory LOD.
Naphthalene - <2ppm	The most soluble SVOC (Naphthalene) has not been identified at concentrations greater than 2mg/kg.
Total PAH <10ppm	Concentrations of low solubility PAH compounds greater than 10mg/kg have not been detected in the soil analysis.
PCB < 1ppm	An electrical substation is located in the eastern sector. Further assessment of the potential for PCBs will be required as part of the Remediation and Enabling Works when made safe.
Heavy metals - <500ppm	Localised concentrations of arsenic and lead above 500mg/kg have been recorded.

To confirm absence of any risk to controlled waters, E3P has undertaken a Tier I controlled waters risk assessment. The Tier I assessment has included a comparison of leachate and groundwater analysis to Environmental Quality Standards (EQS) in the first instance and where absent Drinking Water Standards (DWS).

The results of the comparison are presented in Table 9.4 overleaf.

Table 9.4 Comparison of Groundwater Analysis with Tier 1 Screening Levels

DETERMINAND	UNITS	EQS SCREENING VALUE ^{1, 2, 3}		DWS ^{3,4}	N	MC	LOC OF EX	ASSESSMENT
		AA	MAC					
Arsenic	µg/l	50	-	10	10	25.9	N/A	No Further Action
Cadmium	µg/l	0.08	0.45	5	10	0.21	N/A	No Further Action
Chromium (VI)	µg/l	3.4	-	-	10	17	N/A	Further Assessment
Copper (hardness)	µg/l	1-28		2000	10	14	N/A	No Further Action
Total Cyanide	µg/l	1	-	50	10	18	N/A	Further Assessment
Lead	µg/l	1.2	14	10	10	8.5	N/A	No Further Action
Mercury	µg/l	-	0.07	1.0	10	<0.5	N/A	No Further Action
Nickel	µg/l	4	34	20	10	9.1	N/A	No Further Action
Selenium	µg/l		-	10	10	15	N/A	Further Assessment
Zinc(hardness)	µg/l	8-125	-	-	10	18	N/A	No Further Action
pH	6-9				10	7.1-8.0	N/A	No Further Action
PAH								
Naphthalene	µg/l	2	130	10*	10	<0.01	N/A	No Further Action
Anthracene	µg/l	0.1	0.1		10	<0.01	N/A	No Further Action
Benzo[b]fluoranthene	µg/l	1.7 ⁻⁴	0.017		10	<0.01	N/A	No Further Action
Benzo[k]fluoranthene	µg/l	1.7 ⁻⁴	0.017		10	<0.01	N/A	No Further Action
Benzo(a)pyrene	µg/l	1.7 ⁻⁴	0.27		10	<0.01	N/A	No Further Action
Fluoranthene	µg/l	0.0063	0.12		10	<0.01	N/A	No Further Action
Benzo(ghi)perylene	µg/l	1.7 ⁻⁴	8.2 ⁻³		10	<0.01	N/A	No Further Action
TPH								
TPH C5-C6 (benzene)	µg/l	10	50	1	10	<10	N/A	No Further Action
TPH C6-C8 (toluene)	µg/l	50	-	700	10	<10	N/A	No Further Action
TPH C8-C10 (ethyl benzene)	µg/l	20	-	300	10	<10	N/A	No Further Action
TPH C10-C12 (xylene)	µg/l	30	-	500	10	<10	N/A	No Further Action
TPH C12-C16 (naphthalene)	µg/l	2	130	10	10	<10	N/A	No Further Action
TPH C16-C35	µg/l	50#	50#	-	10	<10	N/A	No Further Action

Notes

Solubility <0.01µg/l

AA – Annual Average

MAC- Maximum Admissible Concentration

* Sum of The specified compounds are benzo[b]fluoranthene (CAS 205-99-2), benzo[k]fluoranthene (CAS 207-08-9), benzo[g,h,i]perylene (CAS 191-24-2) and indeno[1,2,3-c,d]pyrene (CAS 193-39-5)

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)

Referring to Table 9.4 above, for the purposes of the Tier 1 assessment E3P has compared the laboratory test data directly to the EQS values (for the protection of surface water quality).

This comparison indicates that the data exceeds for the following inorganic compounds:

- Chromium VI
- Total Cyanide
- Selenium

The elevated concentrations were all recorded within leachate samples. It should be noted that the Tier I assessment criteria provides a conservative view, which may over-state the risk. Inorganic determinands identified above are of a general low solubility and therefore mobility, suggesting that these will not migrate to controlled water receptors.

Furthermore, chemical analysis from groundwater samples (5 No. across the site) and the River Irk up-gradient (RS1), adjacent (RS2) and downgradient (RS3) did not record concentrations above the EQS threshold for any contaminants of concerns.

No SVOC or VOC concentrations above the Limit of Detection (LOD) were recorded within the groundwater or surface water (River Irk).

Therefore, there site is considered to pose no unacceptable level of risk to controlled water or the wider environ.

Given the sensitivity of the site with respect to the proximity of the River Irk, careful consideration of construction run-off will be required.

9.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 (*Assessing risks posed by hazardous ground gases to buildings*, 2007). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on-site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

The Phase I report and subsequent Ground Investigation has identified the following potential sources of ground gas:

-  Made Ground Deposits to a proven depth of 3.45m bgl;
-  Two in-filled reservoirs within the site boundary;
-  The South of Blackley New Road landfill c. 10m to the northeast of the site; and
-  Potential hydrocarbon impact to shallow soils;

During the monitoring visits completed to date, slightly elevated concentrations of carbon dioxide (up to 5.9%v/v) were recorded. No significantly elevated concentrations of methane were recorded within any of the probeholes.

During the monitoring a negative flow was noted in a number of boreholes which is indicative of back pressure from wind being greater than the active flow from the wells.

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 maximum GSV calculated for methane was 0.0058 l/hr (WS103) and for carbon dioxide was 0.03906 l/hr (WS103).

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.

The current industry guidance within CIRIA665 and BS8485 requires that where carbon dioxide in excess of 5% is identified and the maximum GSV are <0.07 l/hr; the ground gas classification falls within Characteristic Situation 2 / Amber 1 requiring ground gas mitigation measures in the construction of new dwellings.

Ground gas measures in accordance with Characteristic Situation 2 will require construction in line with BS8485 which requires a minimum of 3.5 points be achieved by installation of a suitable combination of measures detailed below:

GAS PROTECTION SCORES FOR THE STRUCTURAL BARRIER		SCORE
a) Floor and substructure design		
Precast suspended segmental subfloor (i.e. beam and block).		0
Cast in situ ground bearing floor slab (with only nominal mesh reinforcement).		0.5
Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations.		1 or 1.5
Basement floor and walls conforming to BS 8102:2009, Grade 2 waterproofing.		2
Basement floor and walls conforming to BS 8102:2009, Grade 3 waterproofing.		2.5
PROTECTION ELEMENT SYSTEM	SCORE	COMMENTS
Gas protection scores for ventilation protection measures		
(a) Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building)	0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems. If the layer has a low permeability and / or is not terminated in a venting trench (or similar), then the score is zero.
(b) Passive sub floor dispersal layer: Media used to provide the dispersal layer are:  Clear void  Polystyrene void former blanket  Geocomposite void former blanket  No-fines gravel layer with gas drains  No-fines gravel layer	Very good performance	The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B of BS8485:2015. Passive ventilation should be designed to meet at least "good performance".
	Good performance	
(c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a sub floor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers.	1.5 to 2.5	This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least "good performance".

(d) Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket.	1.5 to 2.5	This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient "coverage" of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least "good performance".
(e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)	4	Assumes that the car park is vented to deal with car exhaust fumes, designed to <i>Buildings Regulations 2000, Approved Document F [9]</i> .

Gas protection score for the gas resistant membrane

Gas resistant membrane meeting all of the following criteria:  Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method_;  Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;  Sufficiently strong to withstand in-service stresses (eg settlement if placed below a floor slab);  Sufficiently strong to withstand the installation process and following trades until covered (eg penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools etc);  Capable, after installation, of providing a complete barrier to the entry of the relevant gas; and,  Verified in accordance with CIRIA C735.	2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. For example, a minimum 0.40mm thickness (equivalent to 370g/m² for polyethylene) reinforced membrane (virgin polymer) meets the performance criteria opposite. If a membrane is installed that does not meet all the criteria opposite then the score is zero.
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This is an interim assessment based on preliminary ground gas readings, the final classification will be supplied as an addendum to this report on completion of the remaining monitoring visits.

9.4 Conceptual Site Model

Following the completion of the intrusive site investigation, chemical analysis and risk assessment the conceptual model shown in Table 9.5 below has been prepared for the site.

Table 9.5 Conceptual Model

SOURCE	EXPOSURE	POTENTIAL PATHWAY
Human Health		
Carbon Dioxide (Ground Gas)	Vertical Migration Accumulation / Inhalation	Residential End Users
Discussion: Elevated concentrations of carbon dioxide have been identified during the ground gas monitoring, although these are associated with low flow rates. The elevated concentrations will be mitigated by ensuring that the buildings sub-structure meets Characteristic Situation 2 and that validation of such measures are completed to ensure that the adopted precautions are installed to a sufficient standard.		
Heavy Metals / PAHs / Non-volatile TPH	Soil Ingestion and Dermal Contact Consumption of Homegrown Vegetables.	Construction Workers Residential End Users
Discussion: Heavy metal, PAHs and non-volatile TPH compounds have been identified in Made Ground soils at the site. The contaminants pose a short term risk to construction workers who may come into contact with impacted soils during any future earthworks. All construction works must be undertaken using the appropriate health and safety controls and where required Personal Protective Equipment (PPE) to remove this potential risk. Furthermore, external areas of the proposed development will comprise hardstanding or a chemically suitable cover system design in accordance with BRE465 (<i>Cover Systems for Land Regeneration</i>) in all garden and landscaped area, thereby removing the exposure pathway and mitigating the risk to human health for future residential site users.		
Asbestos Containing Materials (ACM)	Fibre / Dust Inhalation	Construction Workers Residential End Users Third Party Property
Discussion: Asbestos (amosite, chrysotile, crocidolite) has been identified within the Made Ground deposits which could be released during earthworks and then subsequently inhaled by construction workers and possibly third party property. Construction phase health and safety controls and the fact that any ACM will likely be buried at depth means that asbestos is likely to represent a low risk with appropriate controls, and in addition, the presence of hard-standing and/or a cover system will ensure that there is no unacceptable exposure risk to future site users.		
Controlled Waters		
Cyanide / Heavy Metals Hydrocarbon Compounds	Vertical / Lateral Migration	River Irk Principal Aquifer
Discussion: The underlying Principal Aquifer (solid geology) is not considered to be a sensitive receptor given the absence of any potable water abstractions within the locality. Elevated concentrations of heavy metals have been identified within leachate samples, these contaminants are of low solubility and therefore mobility. For the avoidance of doubt, no elevated concentrations of contaminants above the EQS thresholds were recorded within the groundwater. Furthermore, chemical analysis of the River Irk at three locations did not record any elevated concentrations, and as such the site is not considered to pose a significant risk to controlled waters and/or aquatic ecosystems in the River Irk.		

10. GEOTECHNICAL ASSESSMENT

10.1 Proposed Development

E3P understands that Endeavour are involved with respect to the proposed redevelopment of the site for residential use comprising the construction of 76 No. dwellings with associated access and estate roads, driveways, garden and landscaped areas and adopted utility infrastructure.

10.2 Summary of Ground Conditions

Topsoil

A 250mm horizon of gravelly SILT (Topsoil) was encountered at TP114.

Made Ground

Made Ground was encountered within all exploratory locations to a maximum proven depth of 3.45m bgl (WS112) underlying the former bleach works, although generally to depths in excess of 1.0m bgl across the wider site.

Made Ground deposits were generally uniform and comprised a silty and/or sandy gravel of concrete, brick, ash, mudstone, sandstone, slate, plastic, timber and metal believed to be associated with historic fill material resulting from construction and demolition activities. Localised discontinuous sandy and/or gravelly clay soils and reworked sand were recorded.

Drift

Drift deposits were encountered within all exploratory hole locations where the Made Ground could be fully penetrated to a proven depth of 5.45m bgl and generally comprised a silty and/gravelly very loose to medium dense SAND with localised areas of very loose to loose sandy SILT within the eastern sector in close proximity to the River Irk.

A number of stiff to very stiff medium to high strength gravelly CLAY bands were recorded underlying the Made Ground soils, typically across the central portion of the site.

Solid

No solid geology was encountered as part of the site investigation.

10.3 Site Preparation

The site should be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the Specification for Highway Works. This should include:

-  Any roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill;
-  No invasive plant species have been identified at the site. If encountered, the infested soils will require treatment / removal by a suitably qualified contractor;
-  Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill;
-  Buried structures and relic foundations are anticipated underlying the existing structures. These features should be excavated from below the proposed development footprint with the resulting void backfilled; and,
-  Consideration should be given to any proposed retaining structures on the site and should be assessed by a structural engineer prior to development.

10.4 Foundation Conditions & Assessment of Potential Bearing Capacities

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has undertaken an assessment of the net safe Allowable Bearing Pressure (ABP) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum.

Table 10.1 Summary of ABPs

NATURAL COHESIVE SOILS			
DESCRIPTION	DEPTH RANGE (m BGL)	UNDRAINED SHEAR STRENGTH (CU) kN/m ²	ALLOWABLE BEARING PRESSURE (kN/m ²)
Gravelly CLAY	2.00 – 2.45	65 – 70	130 – 140
Gravelly CLAY	3.00 – 3.45	60 – 90	115 – 190
Gravelly CLAY	4.00 – 5.45	50 – 145	105 – 300
NATURAL GRANULAR SOILS			
DESCRIPTION	DEPTH RANGE (m BGL)	RELATIVE DENSITY	ALLOWABLE BEARING PRESSURE (kN/m ²)
SILT / SAND	1.00 – 2.45	Very Loose to Medium Dense	10 – 165
SILT / SAND	3.00 – 3.45	Very Loose to Medium Dense	35 – 145
SILT / SAND	4.00 – 5.45	Loose to Dense	50 – 305

Based on the assessment of the relative undrained shear strength, relative in-situ densities and corresponding safe net ABP, the target founding stratum has been identified as the stiff to very stiff medium-high strength gravelly CLAY or loose to dense SAND at a depth of between 3.00-5.45m bgl where an ABP of between 50-305kN/m² can be achieved.

10.5 Foundation Solution

Prior to the detailed design of suitable foundation solutions, a programme of remediation and enabling works will be required to remove any buried obstructions, remediate the contamination hotspots and cut / fill the site to suitable development platform levels.

It is anticipated that on completion of the proposed site remediation and enabling works, the ground will generally comprise circa 2.00-3.00m of variable Made Ground. The Made Ground is not considered suitable founding stratum (in its current condition) due to its inherent variability and unquantifiable potential for long term total and differential settlement.

The geotechnical assessment confirmed that the natural stratum that will provide the required safe ABP is generally at a depth in excess of 3.0m and as such the use of a traditional spread footing (strip or trench fill) is likely to be unviable for the construction of the proposed dwellings.

It may be feasible to remediate the Made Ground to facilitate re-engineering using a vibro replacement stone column (VRSC) to remove the variability within the Made Ground and facilitate the construction of doubly reinforced strip foundations at a shallow depth. Improving the Made Ground may generate a significant amount of unsuitable organic material that would require placement outside any area of proposed structure / infrastructure.

Conversely, the lifting and processing of the existing concrete slab is likely to generate a large volume of re-usable (pending confirmatory analysis) aggregate to re-engineer as part of the development platform. Should there be a shortfall, it may be necessary to import suitable engineered fill.

The vibro granular columns could provide a bearing capacity of around 125kN/m² but will also remove variability within the Made Ground. Specialist advice should be sought from a suitably experience contractor with regard to allowable bearing capacity and settlements.

However, due to the presence of variable Made Ground and localised very loose granular soils within the near surface it may be necessary to use a pile foundation which are capable of transferring structural loadings to a competent strata.

Consideration must also be given to the varying soil matrices and differing settlement characteristics and where a foundation spans two varying matrices the sub-structure should be designed accordingly.

The final foundation solution will be dependent on the structural loadings and elevation and should be designed by a suitably qualified structural engineer as and when a proposed development scheme in finalised and finished floor levels (FFLs) are known.

A Depth to Founding Strata Plan is included as Drawing 11-164-007 in Appendix III.

10.6 Ground Floor Slabs

Due to the presence of substantial thickness' of Made Ground it is considered that ground bearing floor slabs are not viable in this instance. Where suspended floor slabs are employed ventilation of the under floor void will be required to address condensation issues. This would also assist in the mitigation of potential gas ingress issues.

10.7 Assessment of Ground Improvement Viability

E3P has prepared the following ground improvement design risk matrix (below) to ensure that the ground conditions are have been proven by the intrusive Site Investigation are satisfactory to facilitate appropriate stabilisation:

Table 10.2 *Ground Improvement Design Matrix*

RISK ITEM	COMMENT	PASS / FAIL
Soft clays with an undrained shear strength less than 30kN/m ² (Note; for clay strengths less than 30kN/m ² .	Clay soils are generally stiff to very stiff with Cu >100kN across the site.	PASS
Ground with peat layers close to foundation level or the base of the stone column, or where intermediate layers of peat are thicker than 200mm either as a single layer or the sum of the thicknesses of individual layers throughout the length of the stone column.	None identified.	PASS

RISK ITEM	COMMENT	PASS / FAIL
Voided filled ground, eg old water tanks, pottery, glass bottles, concrete rubble or brick fill of unsuitable grading	Made Ground soils contain a high content of brick fill and concrete.	PASS (Subject to remediation)
Loose or non-engineered fill not previously subject to rising or fluctuating water levels or saturation	None identified	PASS
Filled ground still settling or expected to settle under its own weight or due to the effects of surcharging/up-filling where there is a high organic content or where decay is continuing.	Two in-filled reservoirs may still be subject to settlement.	PASS (Subject to remediation)
Fill, containing degradable material where organic material forms more than 15% of fill by volume	Organic materials form <15% by volume.	PASS
Clays with a plasticity index greater than 40%	Clay plasticity index results indicate the cohesive depots to be of Low Plasticity (<20%).	PASS
Highly sensitive soils liable to collapse or remoulding	None Identified within the site boundary.	PASS
Cohesive soils with trees in influencing distance.	The site is predominantly underlain by granular soils with occasional clay strata, however there are a number of trees located around the periphery of the site which are to be retained.	Subject to assessment of tree influence. Alternative foundation solution may be required in these areas.
Overall Risk Rating & Suitability for Vibratory Ground Improvement		PASS

10.8 Heave Precautions

The site has been proven to be partly underlain by clay soils which are susceptible (albeit unlikely) to volumetric instability due to fluctuations in moisture content, particularly within influencing distance of trees as per the NHBC / LABC conjectured zones of influence.

As the clay is deemed to be low plasticity Heave Precautions are not required to the internal face of the external load bearing walls (outside or within tree influence).

If a ground beam is to be constructed within the zone of tree influence, heave precautions are required to the underside of this and edge beams.

If the ground floor slab is to be constructed with a beam and block floor, a minimum sub-floor void of 200mm is required within any structures located in the zone of conjectured tree influence.

If the ground floor slab is constructed with a cast in-situ suspended floor slab heave precautions that can tolerate 50mm of clay swelling are required within any part of the floor slab to be located within the zone of influence of a tree.

Heave precautions are summarised in Table 10.3.

Table 10.3 Summary of Heave Precautions

		MINIMUM VOID DIMENSION FOR FOUNDATIONS, GROUND BEAMS AND SUSPENDED IN-SITU CONCRETE GROUND FLOORS		MINIMUM VOID DIMENSIONS UNDER PRE-CAST CONCRETE AND SUSPENDED TIMBER FLOORS
Plasticity Index of Soil	Required Foundation Depth (m)	Thickness of Void Former Against Side of Foundation or Ground Beam (mm)	Thickness of Void Former on Underside of Edge Beam and Floor Slab (mm)	Void Dimension (mm)
High Plasticity (>40)	>2.50	Engineer Design		Engineer Design
	2.00-2.50	35	150	300
	1.50-2.00	25	75	
Moderate Plasticity (20-40)	>2.50	Engineer Design		Engineer Design
	2.00-2.50	25	100	250
	1.50-2.00	25	50	
Low Plasticity (<20)	2.00-2.50	-	50	200
	>2.00	No Special Precautions		

10.9 Pavement Construction

An assessment of the CBR % to assist in the design of highway infrastructure has not been completed for the purpose of this report due to the presence of a substantial concrete slab across the majority of the site and variable Made Ground deposits within the external areas.

A programme of remediation and enabling works will be required to remediate the proposed road sub-grade in accordance with the requirements of the highways design manual (series 600) for a Method Compaction.

It is considered that the Made Ground material can be re-engineered to a method to achieve a CBR in excess of 5% if works are completed in favourable climatic conditions.

Following excavation, the sub formation should be proof rolled and any soft material inspected and removed during favourable climatic conditions to prevent exposure to precipitation.

10.10 Drainage

The presence of substantial depths of Made Ground across the site may result in settlement. It is therefore recommended that drain runs are designed using steeper gradients and flexible joints to allow for some differential settlement.

The natural underlying predominantly granular soil matrix is likely to offer the required degree of permeability to facilitate the use of soakaway drainage systems. However, due to the presence of both inorganics and olfactory hydrocarbon impact in the soils, it is not recommended that soakaways are used for disposal of surface water runoff.

If soak-away drainage is to be considered, full BRE365 Testing must be completed to inform the detailed design.

10.11 Concrete Durability

Based upon the results of the chemical analyses summarised in Table 8.4 it is considered that subsurface concrete can be designed in accordance with Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with the recommendations provided in BRE Special Digest 1 (2005).

Localised areas which meet DS-2 AC-2s were encountered at TP105 & TP115, however, it is anticipated that following a phase of remediation and enabling works, the soils will meet class DS-1 and AC-1s.

10.12 Excavations

The sides of the exploratory trial pit excavations appeared to be generally unstable during excavation due to the predominantly granular nature of the Made Ground and underlying natural soils.

The boreholes were advanced with relative ease through the natural soils and generally excavations should be feasible as part of future works with normal plant.

Relict foundations have been encountered and the presence of further below ground obstructions cannot be discounted. Any previously unidentified sub-structures will require grubbing out in their entirety during the reduced level dig for the sub structure works.

Groundwater strikes were recorded between 0.50-4.00m bgl. Subsequent monitoring by E3P indicates the presence of shallow groundwater at depths of between 0.50-3.50m bgl.

10.13 Re-Use of Materials

Further assessment of the soils immediately underlying the former tanks will be required as part of the Remediation and Enabling works to determine if the materials can be re-used.

ACM has been identified in the shallow Made Ground. This material will require careful management and placement in accordance with the CIRIA guidance and the Control of Asbestos Regulations (CAR) regulations.

The Made Ground soils are not suitable for re-use as part of the soft cover system within any proposed garden and landscaped areas.

Chemical analysis of the underlying natural cohesive strata indicates this material is suitable for re-use as part of the sub-soil element of the aforementioned cover system.

10.14 Minerals

There are no minerals of economic value underlying the site at shallow depth and mining is considered to be very unlikely. The site is considered to be minerally stable.

10.15 Further Works

Based on the findings of the intrusive site investigation, the following additional works are recommended to be completed in due course:

-  Further assessment for Sodium Hypochlorite and SVOCs within footprint of former the bleach works;

-  Further assessment for PCBs in proximity to electrical substation;
-  Remediation & Enabling Works Strategy;
-  Arboriculture Survey;
-  Foundations to be designed by suitably qualified Structural Engineer;
-  Geotechnical Earthworks Compaction Specification (Infrastructure); and,
-  A Materials Management Plan should be completed on receipt of the proposed FFLs.

10.16 Construction Activity and Inspection

The following activities and inspections should be incorporated in to the site works:

-  Due to the variability of the soils at the site and presence of buried obstructions it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction:
-  Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 utilised;
-  It is considered that de-watering may be required, particularly following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to provision of space for settling tanks or an attenuation pond;
-  Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan. Particular account should be taken of the gas results;
-  The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

11. CONCLUSIONS AND RECOMMENDATIONS

Contaminated Land

Human Health	The preliminary Tier I Human Health risk assessment has identified the presence of heavy metals, non-volatile PAHs / TPH compounds and asbestos within the sub-surface at a number of locations across the site. Asbestos has been identified within the shallow Made Ground, and as such it will be necessary to carefully manage these impacted soils and place them in a legislatively compliant manner that will negate any possibility of future exposure. External areas will be covered by hard-standing or a chemically suitable cover system within all private garden and landscaped areas thereby removing the exposure pathway to future site users. It is possible that as yet unidentified hydrocarbon impact is present within localised hotspots underlying the existing structures and location of former tanks. It is considered that any such contamination could be addressed by the delineation, excavation and treatment of impacted soils.
Controlled Waters	Given the absence of any elevated soluble contaminants within the groundwater or River Irk and thus a complete pollutant linkage the site is not deemed to pose an unacceptable degree of risk to controlled waters. Careful consideration of construction run-off will be required.
Ground Gas	Ground gas monitoring to date (ongoing) indicates the site falls into classification Characteristic Situation 2 due to elevated carbon dioxide concentrations and special precautions will be required as part of the residential development.
Potable Water	It is considered that a well designed and implemented programme of remediation and enabling works should negate the need for contaminant resistant infrastructure. A full UKWIR assessment will be required.

Geotechnical Issues

The Made Ground deposits are not considered a geotechnically suitable founding material due to the low and variable ABPs and unquantifiable potential for long term total and differential settlement;

The presence of variable Made Ground and localised very loose sands within the near surface drift deposits to depths of ~3.0m would indicate that (based on current elevations) the depth to competent founding stratum would preclude the use of a traditional spread (strip / trench fill) type foundation.

It is therefore recommended that due consideration be given to the use of vibro replacement stone columns or a piled foundation capable of transferring structural loads to competent stratum.

However, the final foundation solution will be dependent on the structural loadings and elevation and should be designed by a suitably qualified structural engineer with consideration of allowable bearing capacity as and when a proposed development scheme has been confirmed and finished floor levels (FFLs) are known.

The Made Ground (excluding organic soils at the near surface) may provide a sub-grade formation to support proposed roads and infrastructure with a likely CBR in excess of 5%;

The site is not located in an area of historic mine workings or ground instability and the risk of future subsidence is considered to be very low; and

The predominantly granular soils are likely to offer the required degree of permeability to facilitate the use of soakaway drainage systems in this instance. 0

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

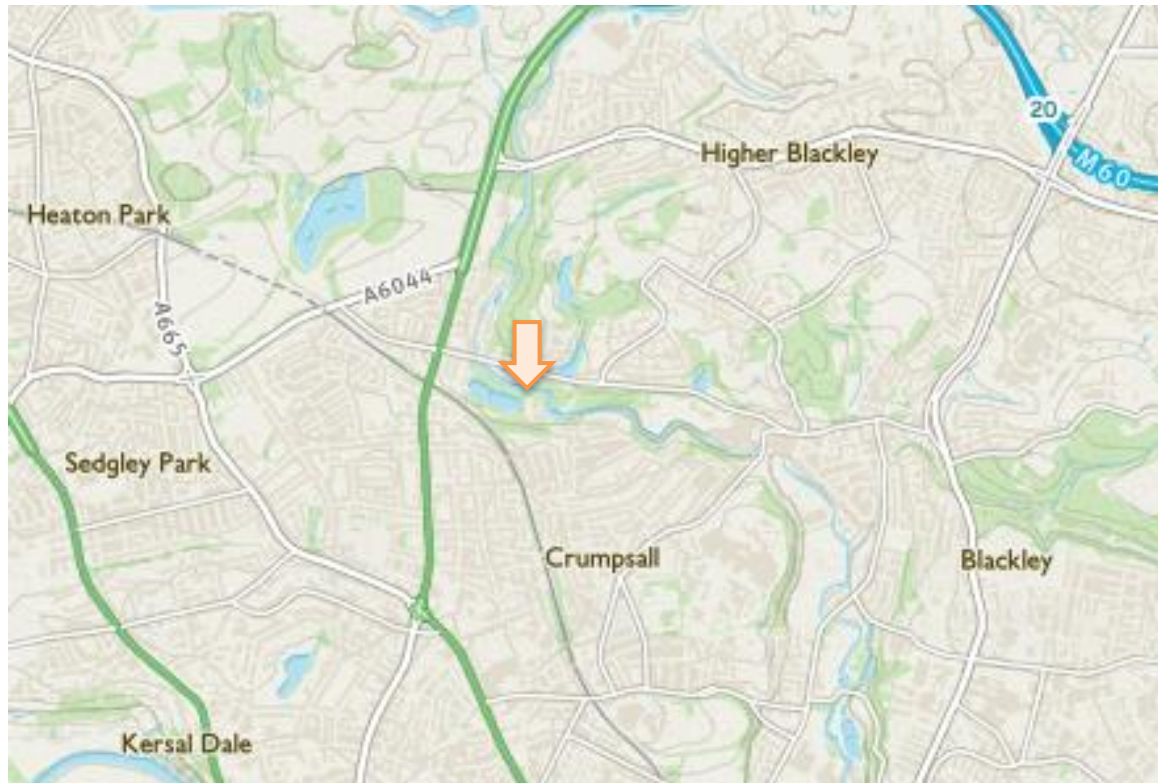
AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

UNITS

m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion
mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million
mg/m ³	Milligram per metre cubed
m bgl	Metres Below Ground Level
m bcl	Metre Below Cover Level
mAOD	Metres Above Ordnance Datum (sea level)
kN/m ²	Kilo Newtons per metre squared
µm	Micro metre

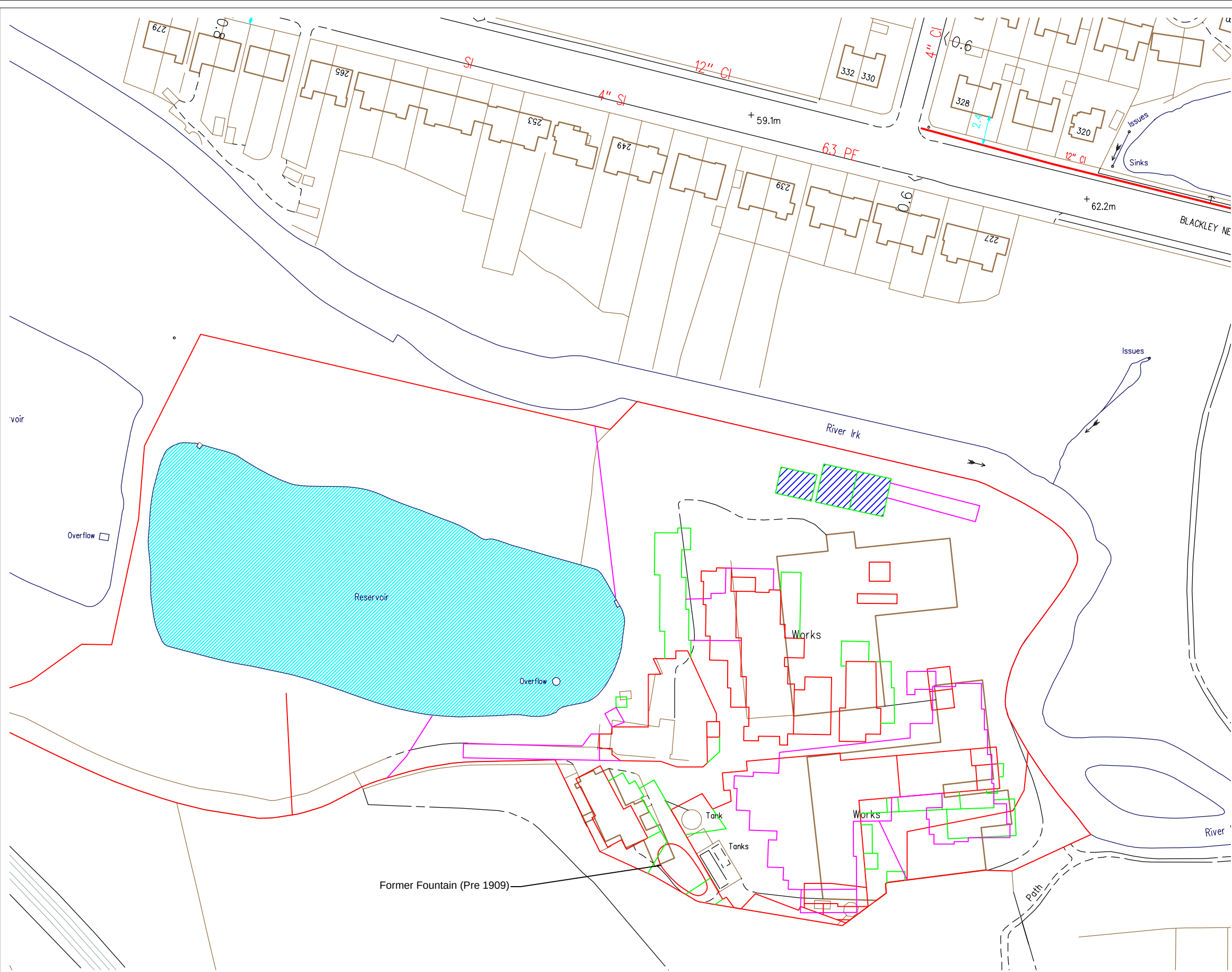
APPENDIX III DRAWINGS





Drawing 11-164-001 - Site Location Plan





- Key:
- Historical Features**
- Former Buildings (Pre 1848 - Pre 1909)
 - Former Reservoir (Pre 1848 - Pre 2016)
 - Former Building Extensions (Pre 1909)
 - Former Reservoir (Pre 1909 - Pre 1999)
 - Former Building Extensions (Bowker Bank Works)
(Bleaching, Dying and Finishing) (Pre 2000 - Pre 2020)

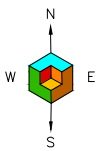
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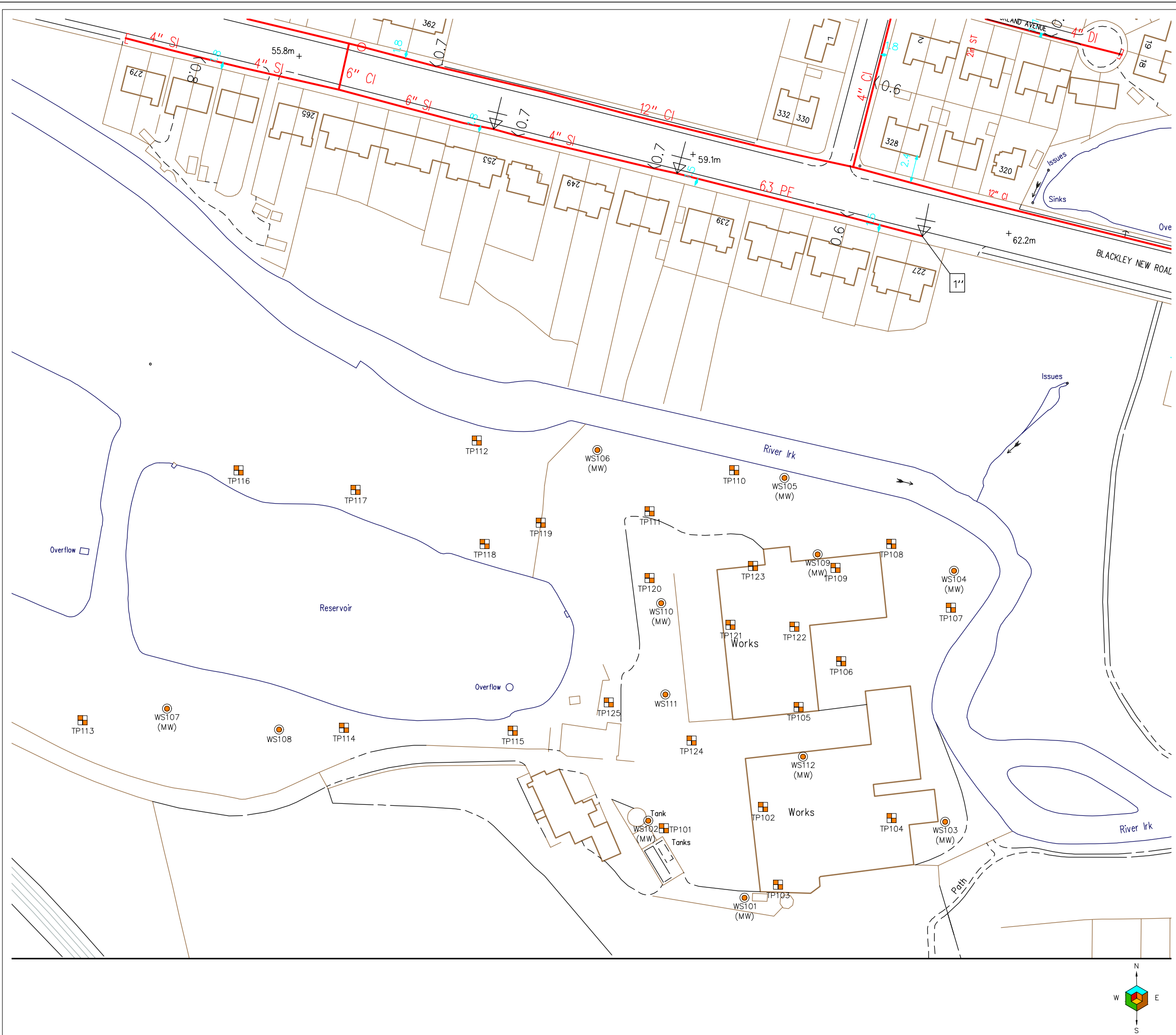
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Client:			Job No:	11-164	Date: 19-10-2016
Evolve			Drawing No:	002	Scale: NTS @ A3
Job Title:			Drawing Title:		
Blakeley Mere			Historical Features Plan		



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Key:

Location Symbols

- WS101 Approximate Window Sample Probehole Location
- WS101(MW) Approximate Window Sample Probehole Location with Install
- TP101 Approximate Trial Pit Location

Notes:

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			Drawing No: 003	Scale: 1:1000 @ A3	
Job Title: Blakeley Mere			Drawing Title: Exploratory Hole Location Plan		

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Key:

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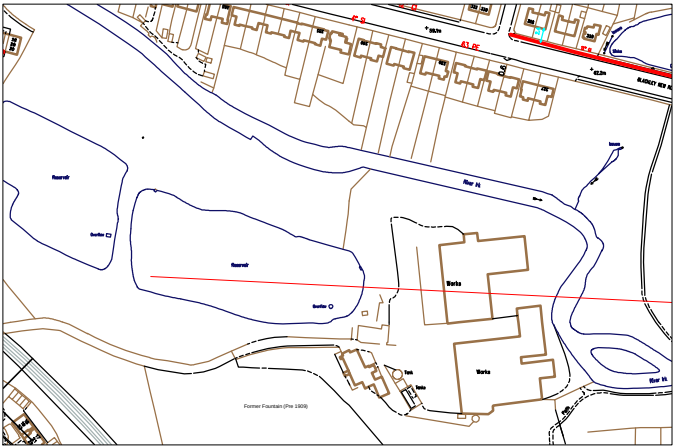
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Evolve			Drawing No:	004	Scale: 1:1000 @ A3
Job Title:			Drawing Title:		
Blakeley Mere			Proposed Development Plan		



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SOURCE		EXPOSURE	Potential Pathway
HUMAN HEALTH			
1	Heavy Metals, heavy end Hydrocarbons & Non Volatile Polycyclic Aromatic Hydrocarbon (PAH)	Dermal Contact and Ingestion	Construction Workers & Residential End Users
		Consumption of Home-grown Produce	Construction Workers & Residential End Users
2	Semi Volatile Polycyclic Aromatic, and petroleum and diesel range Hydrocarbon Compounds, Chlorinated Hydrocarbons	Volatilisation / Accumulation, Vapour Inhalation	Construction Workers & Residential End Users
3	Asbestos Containing Materials (ACM)	Fibre / Dust Inhalation	Construction Workers, Residential End Users & Third Party Property
4	Hazardous Ground Gases	Inhalation	Construction Workers
		Accumulation	Residential End Users
5	PCB's	Dermal Contact and Ingestion	Construction Workers & Residential End Users
		Consumption of Home-grown Produce	Residential End Users
CONTROLLED WATERS			
6	Water Soluble Mobile Contaminants	Vertical Migration	Secondary A Aquifer
7	Water Soluble Mobile Contaminants	Lateral Migration	Surface Water Courses
BUILDING & INFRASTRUCTURE			
8	pH & Sulphate	Corrosion of Concrete	Foundations / Concrete
9	VOC, TPH's Phenols, pH	Chemical Corrosion	Potable Water Supply



Key:

Conceptual Site Model

- Standard Industrial Works
- Site Boundary
- Sand And Silt
- River Irk
- Made Ground
- Graded Platform

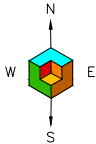
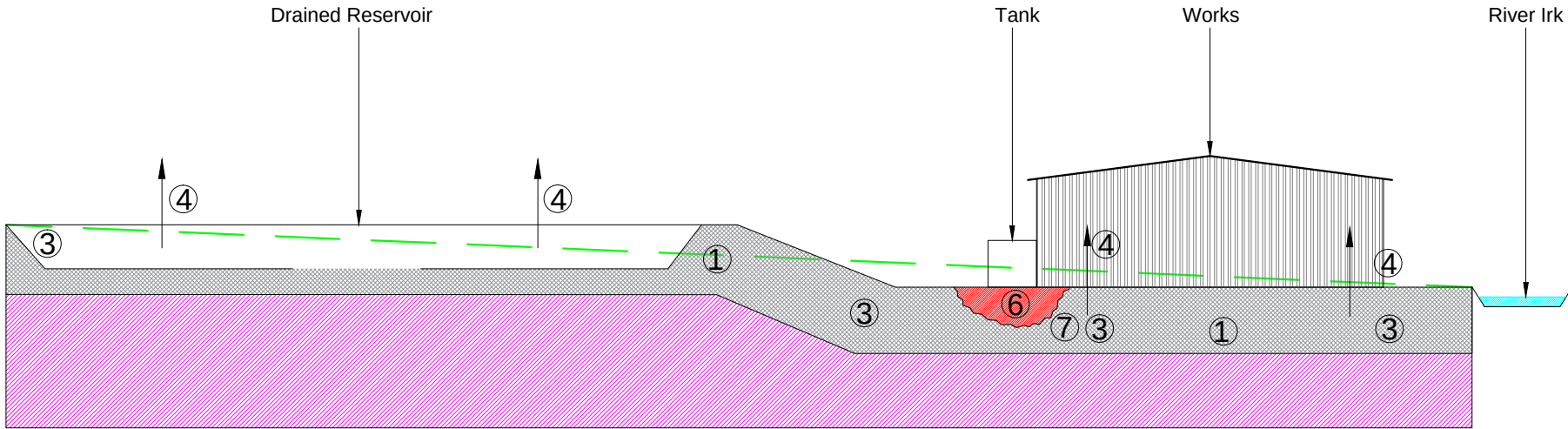
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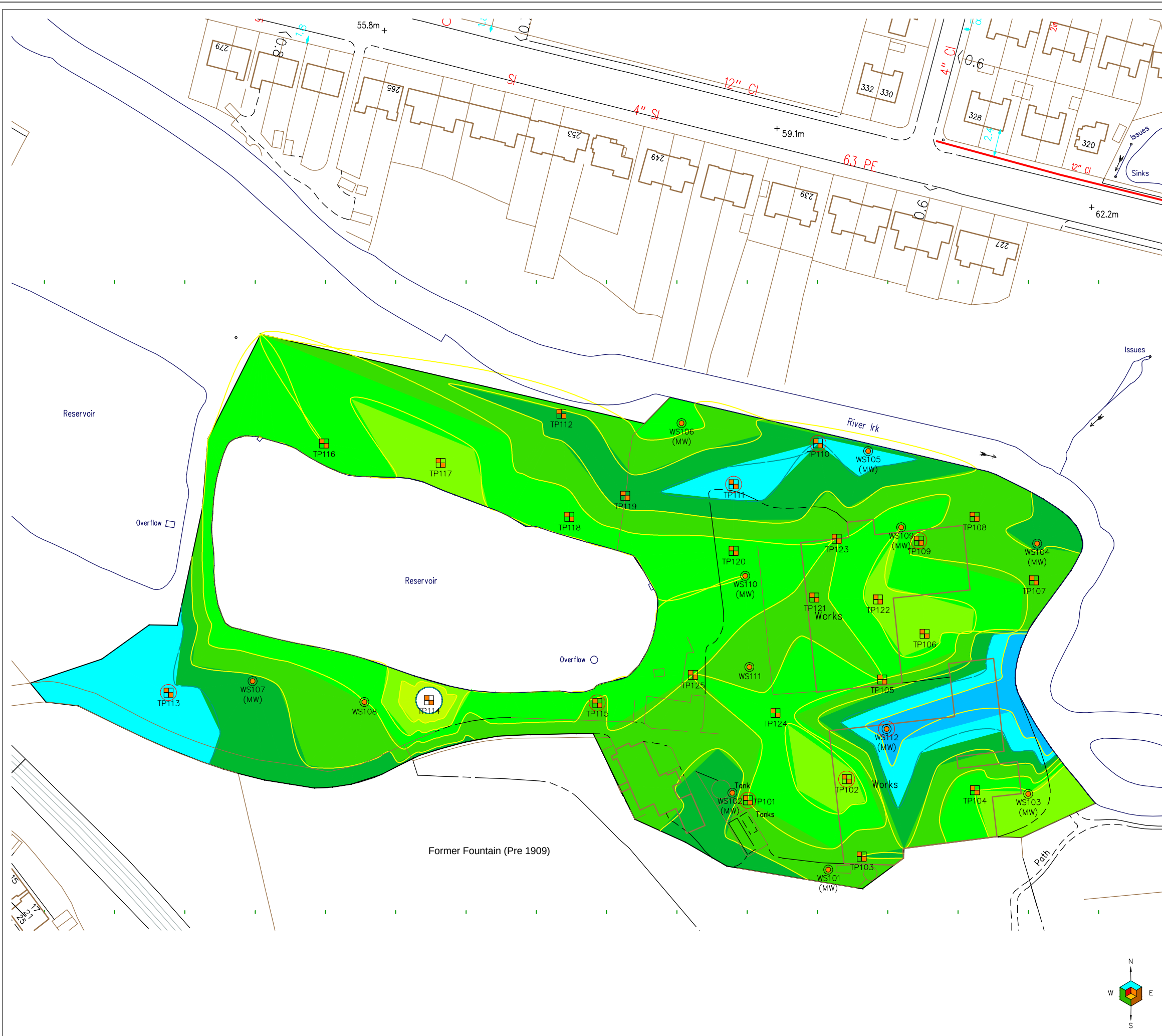
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Job Title:			Drawing Title:		
Blakeley Mere			Conceptual Site Model Plan		

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W E





Key:

Location Symbols

- WS101 Approximate Window Sample Probehole Location
- WS101(MW) Approximate Window Sample Probehole Location with Install
- TP101 Approximate Trial Pit Location

Made Ground Depth (m)

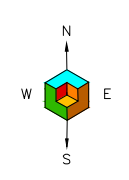
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- Depth of Made Ground Between 0.50 - 0.99m
- Depth of Made Ground Between 1.00 - 1.49m
- Depth of Made Ground Between 1.50 - 1.99m
- Depth of Made Ground Between 2.00 - 2.49m
- Depth of Made Ground Between 2.50 - 2.99m
- Depth of Made Ground Between 3.00 - 3.49m
- Depth of Made Ground Between 3.50 - 3.99m
- Depth of Made Ground Between 4.00 - 4.49m
- Depth of Made Ground Between 4.50 - 4.99m
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- Made Ground in Excess of 6.00m
- Made Ground Not Fully Identified

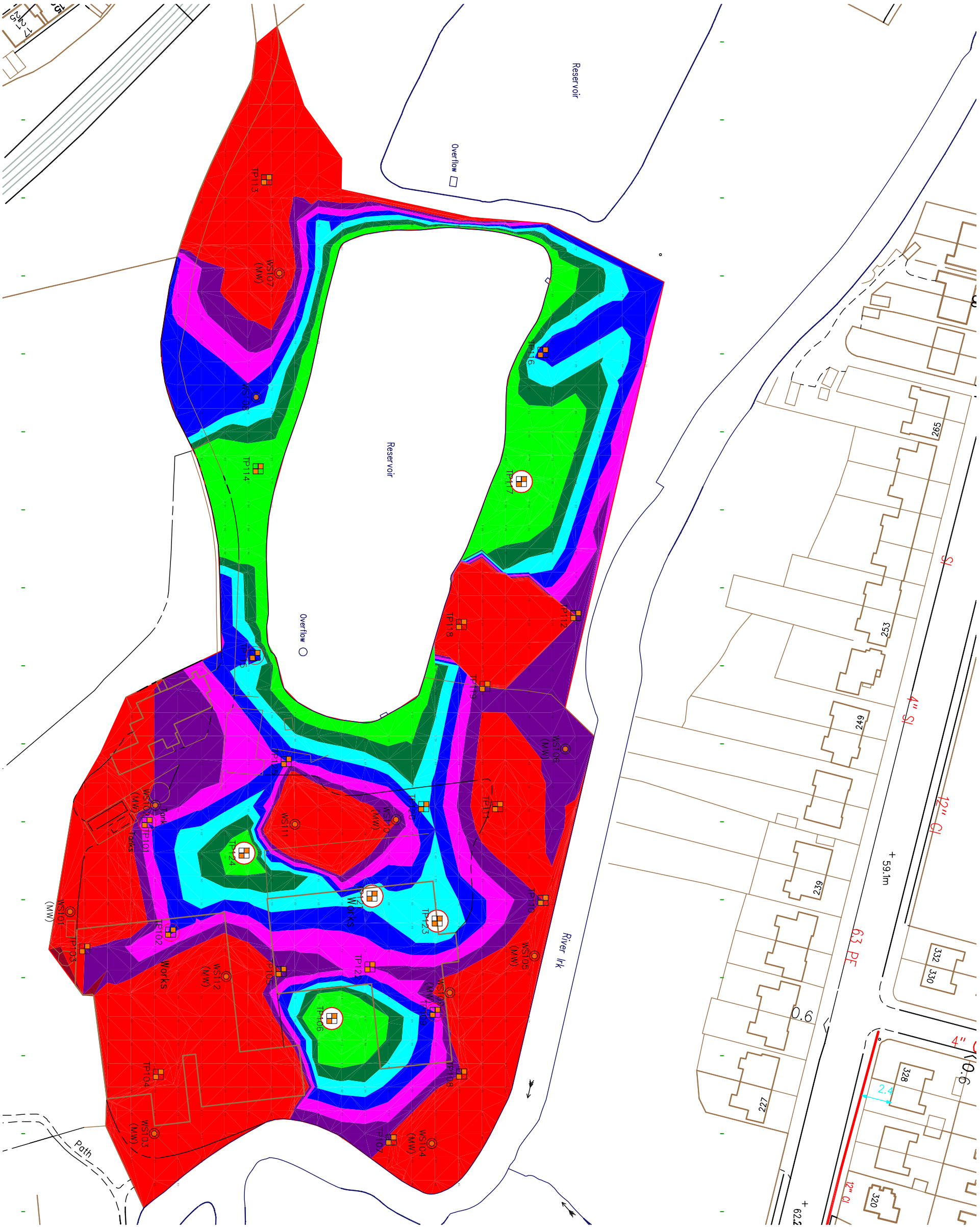
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			Drawing No: 006	Scale: NTS @ A3	
Job Title: Blakeley Mere			Drawing Title: Depth of Made Ground Plan		

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- WS101 Approximate Window Sample Probehole Location
- WS101(MW) Approximate Window Sample Probehole Location with Install
- TP101 Approximate Trial Pit Location

Shallow Spread Footings

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

Mass Trench Fill Footings

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

Engineered Footings

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

Notes

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Client				Job No:				11-164				Date:			
Evolve				Drawing No:				007				Scale:			
Job Title:				Drawing Title:				Depth to Founding Strata Plan				Authorised			
Blakeley Mere				Job Title:				Drawing Title:				Authorised			



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