WML CONSULTING

Civil, Structural and Geotechnical Engineers

Phase 2 Geo-Environmental Investigation & Assessment

For a site at

Arrowfield Road, Chorlton

Undertaken on behalf of

Southway Housing Trust

Report No. 7592/G/02

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WML CONSULTING
Civil, Structural and Geotechnical Engineers

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Executive Summary

Site Location	The site comprises land on the corner of Nell Lane and Arrowfield Road in the Chorlton area of Manchester. It is centred on approximate Ordnance Survey National Grid Reference 382745E, 392954N with an indicative postcode of M21 7UG.
Development Proposals	It is understood that the proposed development comprises the construction of twenty four, two bedroom apartments in a three-storey structure. External areas are indicated to comprise hardstanding for access/parking and localised communal landscaped areas. A gas governor in the south-western section of the site is to be retained as part of the redevelopment. The current proposals indicate the need to realign a public footpath in the north-eastern section of the site and the possible closure of a footpath in the central section of the site.
Ground Conditions	Ground conditions comprise Made Ground to depths of between 0.35m and 1.20mbgl underlain by Glaciofluvial Sheet Deposits to a maximum proven depth of 5.45mbgl.
Site Preparation and Earthworks	No demolition should proceed until an appropriate Asbestos survey of the existing building has been undertaken and any Asbestos Containing Materials (ACM) removed by an appropriately licensed contractor. Ground obstructions in the form of existing foundations, ground floor slabs and other buried concrete obstructions associated with the current site use will need to be broken out to suitable depths below formation levels where they are to impinge on the proposed redevelopment. Demolition materials, existing asphalt/concrete hardstanding and below ground foundations removed as part of the clearance work, subject to appropriate screening and crushing, may be suitable for re-use as bulk fill beneath hard cover areas. Construction near retained trees and importantly within the RPA should be undertaken with due regard to guidance provided in BS5837:2012 'Trees in relation to design, demolition and construction – recommendations'. Topsoil stripped from the area of redevelopment should be stockpiled and protected from inclement weather for future use in garden/landscaped areas subject to confirmatory laboratory testing. The stopping-up and/or realignment of public footpaths will likely be subject to consultation with the local authority and/or Department of Transport.
Foundations and Floor Slabs	It is anticipated that lightly loaded new structures could be supported on traditional shallow spread foundations constructed within the competent natural granular Glaciofluvial Sheet Deposits at depths of no less than 0.75m below existing ground level. Such foundations should be designed on a net allowable bearing pressure not exceeding 125kN/m². Where higher structural loads are anticipated, the ground is likely to be suitable for ground improvement by vibro-compaction. Alternatively, a piled foundation solution could be considered with piles being taken down through the Made Ground and Glaciofluvial Deposits and into the underlying Glacial Till which is anticipated to be within 10m of the surface regionally. Should either of these solution be considered, a specialist contractor should be consulted. In view of the recorded thickness of Made Ground at the site, floor slabs may need to be suspended.
Pavements	New road pavement construction should be designed on a CBR value of no more than 3% for Made Ground and 5% within natural granular deposits.
Concrete Classification	The typical design sulphate (DS) class and "Aggressive Chemical Environment for Concrete" (ACEC) class for the site are DS-1 and AC-1 respectively.
Soakaways	In consideration of the site being underlain by relatively permeable Glaciofluvial Sheet Deposits, soakaways could be a feasible drainage option for the site. However, this would need to be confirmed by appropriate large scale infiltration testing at drainage design stage.

Ground Gas	The results give a maximum composite Qhg value of <0.0059l/hr and indicate the site to classify as Characteristic Situation (CS) 1 – Very Low Gas Risk' in accordance with BS8485:2015 although due to the slightly elevated level of carbon dioxide measured in one standpipe, it may be prudent at this stage to allow for basic gas protection measures such as a lapped and taped gas membrane, taken over cavity walls and sealed at slab penetrations, together with under-floor ventilation of 'Very Good performance' as described in BS8485. This will need to be confirmed on completion of the remaining ground gas monitoring and further gas risk assessment in due course.
Contamination Assessment	In consideration of the chemical test results it is concluded that the site does not contain significant and/or widespread contamination. The localised elevated PAHs are attributed to fragments of ash within the sample matrix. A direct contact pollution linkage could be envisaged in any new landscaped areas and it is recommended that Made Ground exposed at the surface in such areas is removed or is covered by clean sub-soil and topsoil thus removing the pollution linkage. This will normally comprise a 300mm cover of clean imported topsoil over the existing Made Ground. Where the Made Ground is currently less than 300mm thick, it may be more appropriate to excavate and remove it to expose the underlying natural soils prior to placement of a suitable thickness of sub-soil/topsoil.
Potable Water Supplies	The requirement for specific materials and measures to protect the water supply from ground contamination is not envisaged.
Waste Soils Classification	It is likely that the majority of Made Ground would be classified as 'Non-Hazardous' or even 'Inert' with natural deposits classified as 'Inert' for landfill disposal. However, where excavated Made Ground, following inspection, is suspected or found to include significant ACM and/or fibres that cannot be segregated, it may classify as Hazardous, subject to further quantification testing. Therefore, it is the responsibility of the waste producer to undertake testing and classification of any waste soils for disposal to an appropriately licenced landfill in accordance with current guidelines.
Further Investigation and Assessment	The final foundation solution will need to be confirmed by further ground investigations once development proposals, including finished formation levels, have been finalised and ideally once the existing buildings have been vacated and demolished.

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1.0 INTRODUCTION

Appointment

1.1 WML Consulting was commissioned by Southway Housing Trust to undertake a Phase 2 Geo-environmental Investigation and Assessment of a site referred to as Arrowfield Road, located off Nell Lane in the Chorlton area of Manchester.

Proposed Development

1.2 It is understood that the proposed development comprises the construction of twenty four, two bedroom apartments in a three-storey structure. External areas are indicated to comprise hardstanding for access/parking and localised communal landscaped areas.

1.3 A gas governor in the south-western section of the site is to be retained as part of the redevelopment.

1.4 In addition, the current proposals indicate the need to realign a public footpath in the north-eastern section of the site and the possible closure of a footpath in the central section of the site.

1.5 The current proposed layout by JDA Architects, referenced PS0008, is reproduced in Appendix 01.

Objective

1.6 The objective of the Ground Investigation and Assessment was to provide geotechnical recommendations for construction design purposes together with a geo-environmental risk assessment in terms of possible ground contamination.

1.7 To achieve the objective, the following tasks were undertaken:

- Establish, through undertaking a Phase 1 Desk Study, the geological, hydrogeological and environmental setting of the site so as to identify any potential ground constraints to development through a site specific conceptual model and to design an appropriate Phase 2 Ground Investigation in accordance with the Environment Agency (2004) Model Procedures for the Management of Land Contamination, CLR11.
- Characterise the ground conditions in terms of geology, soil geotechnical parameters, mining and ground contamination from information provided by the desk study and Ground Investigation.
- Provide recommendations regarding suitable foundations, floor slabs and new pavement construction, together with any other geotechnical considerations that could affect possible future development.
- Determine a ground conceptual model for the site so as to undertake an appropriate Phase 2 Generic Quantitative Risk Assessment (GQRA).

Scope

1.8 The Phase 1 Desk Study has been undertaken and is presented in the following WML Consulting report:

- Phase 1 Desk Study and Preliminary Geo-environmental Assessment, Reference 7592/G/01, dated April 2017.

1.9 This report includes the findings of a Phase 2 Ground Investigation designed on conclusions and recommendations provided in the Phase 1 Report. For ease of reference, the findings of the Phase 1 Desk Study are summarised in the following sections. The two reports however are not exclusive and should be read in conjunction.

1.10 The ground Investigation comprised the formation of 4no window sample probeholes and 2no hand dug trial pits which were undertaken to replace window sampling probes in less accessible locations of the site.

1.11 The Ground Investigation has been undertaken in general accordance with BS5930:2015 Code of Practice for Ground Investigation.

1.12 The site investigation has also been undertaken in general accordance with BS10175:2011 and A1:2013, "Investigation of Potentially Contaminated Sites - Code of Practice" except where superseded by EN ISO 22475-1 "Geotechnical Investigation and Assessment – Sampling by Drilling and Excavation and Groundwater Measurements".

1.13 Geotechnical soil testing has been undertaken in accordance with guidelines provided in BS1377:1990 – Parts 1-9, "Method of Test for Soils for Civil Engineering Purposes". Samples for chemical analysis were obtained and handled generally in accordance with the current guidelines (BS10175: 2011 and A1:2013) relating to the anticipated nature of possible contamination sources and the intended end use.

2.0 SITE LOCATION AND DESCRIPTION

Site Location

2.1 The site comprises land on the corner of Nell Lane and Arrowfield Road in the Chorlton area of Manchester. It is centred on approximate Ordnance Survey National Grid Reference 382745E, 392954N with an indicative postcode of M21 7UG.

2.2 The proposed development site is bounded to the north-east and east by Buckthorn Close with residential developments beyond. To the south, the site is bounded by Nell Lane and Southern Cemetery. To the west, the site is bounded by Arrowfield Road and Loreto High School.

2.3 The site location is indicated on the topographic plan in Appendix 01.

Site Description

2.4 The site is roughly rectangular in shape and covers an area of approximately 0.24 Hectares.

2.5 The central section of the site is developed with a low-rise brick structure, of which the eastern section provides residential housing and the western section a children's nursery.

2.6 The structure is surrounded by private gardens associated with the residential section of the structure and mixed hardstanding and soft play associate with the nursery.

2.7 The remaining areas comprise undulating grass landscaping and asphalt hardstanding for access and parking with Buckthorn Close extending roughly east to west across the northern and north-eastern sections of the site.

2.8 Designated vehicular parking areas are located within the eastern, northern and western sections of the site.

2.9 Localised semi-mature deciduous trees of varying species are located within the landscaped areas around the site, with the greatest densities closest to the eastern and southern site boundaries.

2.10 A gas governor of brick construction is located in an area of landscaping within the south-western section of the site. The age of the structure is unknown.

2.11 The site is fully accessible with the exception of the children's nursery and private residential properties.

2.12 Surrounding land is mainly occupied by residential development with associated hardstanding and soft landscaping, together with a cemetery and school to the south and south-west respectively.

Topography

2.13 The site is relatively level with a slight decrease in elevation from 30.40m Above Ordnance Datum (AOD) in the south-west to 29.85m AOD close to the north-eastern site boundary. The central section of the site is generally level at around 30.00m to 30.10m AOD.

2.14 However, small landscaped grass mounds, with a maximum elevation of 30.77m AOD, are located along Nell Lane on the south-western site boundary.

3.0 SUMMARY OF ENVIRONMENTAL AND HISTORICAL SETTING

3.1 The following paragraphs summarise the most relevant findings of the Phase 1 Desk Study report.

3.2 The BGS plans indicated that the site is underlain by Devensian Glaciofluvial Sheet Deposits. The Drift deposits are underlain at greater depths by the Triassic Wilmslow Sandstone Formation.

3.3 In consideration of the underlying geology, risks of subsidence from coal mining can be discounted.

3.4 The property is not in a Radon Affected Area as defined by the Health Protection Agency as less than 1% of properties are above the Action Level of exposure. No radon protection measures are therefore necessary for new properties as described in publication BR211 by the Building Research Establishment.

3.5 The Glaciofluvial Sheet Deposits beneath the site are classified by the Environment Agency as a 'Secondary A Aquifer'. The underlying bedrock is classified as a 'Principal Aquifer' (former Major Aquifer).

3.6 There are no Environment Agency Source Protection Zones or active Groundwater Abstraction Licence within 500m of the site.

3.7 There are no recorded Detailed River Network Features within 250m of the site. The nearest relates to Chorlton Brook which is around 420m north and is therefore not considered to be within influencing distance of the site.

3.8 There are no active or non-operational landfills within 1km of the subject site although there is 1no Environment Agency recorded historic landfill relating to a former waste destructor and its associated waste heaps at Nell Lane, 18m south-west. The waste was temporarily stockpiled prior to being burnt rather than landfilled. Therefore, the subject site is not considered to be within influencing distance of any landfills.

3.9 There are 3no potentially contaminative industrial sites within 250m of the subject site but none are close enough to have an impact on the site.

3.10 There is 1no record of a Part B IPPC Authorised Activity within 500m of the site. This relates to a current permit for incineration at The Manchester Crematorium, 354m south-west. This is considered sufficiently remote as to have no effect on the site.

3.11 There are no records of sites which have been determined as Contaminated Land under Section 78R of the Environmental Protection Act 1990 within 500m of the study site.

3.12 Historically, the site remained in rural / agricultural use until it was developed with a residential structure on the southern part sometime prior to 1981. Other than potential part change of use to a children's nursery the site has since remained relatively unchanged.

3.13 The earliest available records indicated the surrounding area to have comprised undeveloped rural / agricultural land with localised residential developments. Nearby industrial development was limited to a Refuse Destructor built some 40m south-west of the site in the 1900's with a Cemetery and Crematorium to the south-west of Nell Lane. The wider area surrounding the site underwent extensive residential development by the 1930's, with the area immediately surrounding the site undergoing residential development by the 1980's.

4.0 PRELIMINARY CONTAMINATION RISK ASSESSMENT

4.1 Based on the above findings, the Phase 1 Desk Study report provided the following Conceptual Model and Preliminary Risk Assessment (PRA) for the proposed development of twenty four, two bedroom apartments in a three-storey structure with external areas of hardstanding for access/parking and localised communal landscaped areas.

Source	Pathway	Receptor	Probability of Linkage	Comment
The likelihood of significant ground contamination sources being present at the site due to its past use is considered low. However, the presence of Asbestos Containing Materials (ACM) within the existing structures cannot be discounted at this stage.	Direct contact, ingestion of soil, dermal contact, dust exposure pathways.	Current Site Users	Unlikely	No significant sources of contamination are anticipated with private gardens and landscaped areas surfaced with grass and / or topsoil. The risk to current site users is therefore considered **VERY LOW**.
		Site End Users	Low	The provision of buildings and new hard cover will break the direct pollution linkage significantly, with direct exposure to contaminants in landscaped areas considered unlikely. Although residual risks could remain within communal gardens, these are considered **LOW**.
		Construction Workers	Unlikely	Construction workers are unlikely to be exposed to significantly contaminated soils during earthworks and foundation construction. Also, any perceived contamination risks will be mitigated by adopting good site working practices including appropriate Health and Safety measures during the works, thus providing a **VERY LOW** preliminary risk.
		Adjacent land users	Unlikely	Contact via wind-blown dust/debris, particularly during the development phase is possible. The current risk is considered **VERY LOW** although this would increase during construction works. Appropriate health and safety measures adopted during site development, will ensure that the risk remains very low.
The likelihood of significant soluble and/or liquid and therefore mobile contaminants occurring at the site due to its past use is considered low.	Direct downward migration through leaching and/or mobile liquids.	Groundwater	Unlikely	The site is indicated to be directly underlain by a Secondary A Superficial Aquifer and a Principal Bedrock Aquifer. Therefore, a direct pollution linkage is plausible although the preliminary risk is assessed as no more than **LOW** due to the likely limited contamination source.

Source	Pathway	Receptor	Probability of Linkage	Comment
	Off-site migration in groundwater or surface water flow.	Surface water	No linkage envisaged	There nearest surface water feature is Chorlton Brook located some 420m north of the site. Therefore, risks to surface water from the site are considered **VERY LOW**.
		Groundwater /surface water abstractions	Unlikely	The site is not within an Environment Agency Source Protection Zone and there are no surface water abstractions within 500m of the site. Therefore, risks to groundwater/surface water abstractions are considered **VERY LOW.**
		Adjacent Properties	Unlikely	No significant sources of mobile contaminants are anticipated at the site. The preliminary perceived risk to adjacent properties is therefore assessed as **LOW**.
		Ecology	No linkage envisaged	There are no Designated Environmentally Sensitive Sites within influencing distance of the subject site. Therefore, risks to the surrounding ecology are considered **VERY LOW.**
The likelihood of significant volatile contamination occurring at the site due to its past use is considered low.	Inhalation of harmful vapours (indoor and outdoor airspaces)	Current Site Users	Unlikely	No significant sources of volatile contaminants are envisaged. Therefore the current risk from inhalation of indoor/outdoor air is considered **LOW**.
		Site End Users	Unlikely	Significant sources of volatile contaminants at the site are not anticipated. Therefore the preliminary risk from inhalation of indoor/outdoor air is considered **LOW.**
		Construction Workers	Unlikely	In the unlikely event of construction workers coming into contact with possible volatile compounds, the exposure time would be relatively short. The chronic exposure risk to construction workers, assuming that appropriate health and safety measures will be adopted, is therefore considered **LOW.**
		Adjacent Properties	Unlikely	Significant sources of volatile contaminants at the site are not anticipated. Therefore the preliminary perceived risk to adjacent properties and users is assessed as **LOW**.

Source	Pathway	Receptor	Probability of Linkage	Comment
The presence of appreciable thicknesses of Made Ground with the potential to generate significant volumes of ground gas beneath the site is unlikely. The Cemetery to the south could contain materials with the potential to generate hazardous concentrations of ground gas, however, such are not considered to be significant. The presence of ground gas resulting from shallow unrecorded mine workings is unlikely.	Emissions from the ground beneath the site collecting in confined spaces and excavations	Construction/ services maintenance workers	Low	Ground workers could possibly come into contact with potentially toxic and/ or flammable/ explosive gas within excavations and confined spaces at the site. Assuming that appropriate health and safety measures will be adopted during construction, the preliminary risk is therefore considered **LOW**.
	Migration of gases on/off site and collecting in confined spaces on/off site.	Adjoining site users	Unlikely	A significant source of potentially degradable material beneath the site is considered unlikely. The preliminary risk to adjoining site users from toxic and/or flammable/ explosive gas arising from the site is therefore considered **LOW**.
		Current/future site users	Low	Although elevated concentrations of ground gases could migrate from the nearby cemetery, the extent of in-fill is such that continued generation of significant volumes are unlikely. The potential risk to current and future site users is therefore considered **LOW** although this will need to be confirmed by an appropriate level of ground investigation and monitoring.
The site is not in an area which is affected by naturally occurring radon gas.	Natural emissions from the ground collecting in confined spaces within buildings	Site end users	Unlikely	The site is not located in an area where radon protection measures are required. No further action is necessary regarding radon protection as the risk is **VERY LOW**.
Chemicals which could prove aggressive to construction materials are unlikely to be present on site.	Direct contact	Construction concrete, plastic water pipes.	Unlikely	Any risks to construction materials identified after site investigation and assessment will be mitigated as part of the structural design. The perceived risk is therefore considered **LOW**.

4.2 Under the proposed development scenario, potential pollution linkages are on the whole considered unlikely with associated preliminary risks being assessed as low.

4.3 However, it has been considered prudent to verify the conceptual model and hence the low environmental risk by undertaking appropriate ground investigation.

4.4 Such uncertainties relate in the main to the potential migration of hazardous ground gas associated with the cemetery to the south.

4.5 This is mainly in view of the potential presence of low level or background ground contamination as a result of the site's brownfield status. The presence of Asbestos Containing Materials (ACM) within the existing structures and Made Ground cannot also be discounted at this stage.

5.0 SITE INVESTIGATION

Rationale

5.1 Intrusive investigations were undertaken primarily to provide geotechnical parameters for structural design purposes but also to verify the preliminary site conceptual model and hence confirm the anticipated very low to low environmental risk.

5.2 Window sample probeholes were undertaken to provide information on near surface deposits and to provide samples for chemical analysis, while minimising disruption of the existing site surfaces.

5.3 A general coverage of the site was considered appropriate although access to locations was locally restricted due to the existing structures, highways and car parks together with existing underground services which include a medium pressure gas main which extends along Arrowfield Road within the grass verge.

5.4 Therefore, in order to provide a more comprehensive coverage of the site, hand excavated trial pits, HP1 and HP2, were located at the edge of the gas main easement.

5.5 In addition, investigations were not possible to internal areas of the existing building.

5.6 Gas monitoring standpipes were installed in selected probeholes for the measurement of ground gas and groundwater levels.

5.7 As no specific historical contaminative use was identified from the Conceptual Site Model, chemical analysis of a general suite of contaminants was undertaken on selected samples of soil. This was to confirm the anticipated low contamination risk and to establish the chemical suitability of soils for possible re-use within the development.

Intrusive Works

5.8 Ground investigation work was undertaken by LOT Geotechnics on 31st May 2017. This comprised the formation of 4no window sample probeholes to a maximum depth of 5.45 metres below ground level (mbgl) and 2no hand dug trial pits to a maximum depth of 1.20mbgl.

5.9 The exploratory hole records are presented in Appendix 02 of this report whilst the exploratory hole locations are shown on sketch Drawing 7592G-SK-01 in Appendix 01.

Monitoring Standpipes

5.10 Monitoring wells were installed in 3no probeholes to allow for potential groundwater and ground gas measurements, as indicated on the logs presented in Appendix 02.

Geotechnical and Chemical Testing

5.11 In-situ geotechnical testing was undertaken at regular intervals during the formation of the probeholes in the form of Standard Penetration Tests (SPTs). The results for this testing are presented on the descriptive logs in Appendix 02.

5.12 Chemical analysis was undertaken on selected soil samples for the following contaminants of concern:

- Total Arsenic, Boron, Cadmium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc.
- Total Cyanide, Phenols, Sulphur, Sulphate.
- Speciated USEPA Polyaromatic Hydrocarbons (PAH).
- Asbestos Screen and Identification.
- 2:1 water/soil sulphate extract, pH.

5.13 The results of the chemical analysis are presented in Appendix 03.

Gas and Groundwater Monitoring

5.14 Gas and groundwater monitoring has been undertaken on one occasion to date, namely 3rd August 2017. The results are presented in Appendix 04.

6.0 GROUND CONDITIONS

Stratigraphy

6.1 Ground conditions encountered during the intrusive investigation generally confirm those identified in the published literature and in summary comprise Made Ground to depths generally of between 0.35 and 0.80mbgl, this being underlain by Glaciofluvial Sheet Deposits to a maximum proven depth of 5.45mbgl.

Made Ground

6.2 Made Ground was encountered within all exploratory holes from ground level to depths of between 0.35m and 0.80mbgl, but locally in excess of 1.20mbgl in HP1. The deeper Made Ground in this area is probably associated with backfill to the gas main service trench.

6.3 Within WS1, WS2, HP1 and HP2 the Made Ground generally comprised a surface horizon of turf underlain by brown, slightly silty, slightly gravelly sand. Gravel sized particles included brick, asphalt, sandstone and ash.

6.4 Within WS2A and WS3 the Made Ground generally comprised a surface horizon of concrete paving slab overlying brown and grey locally gravelly sand to depths of between 0.35m and 0.60mbgl. Gravel sized particles included brick, ash and clinker.

Glaciofluvial Sheet Deposits

6.5 Within the majority of exploratory holes the Made Ground was underlain by strata considered to represent Glaciofluvial Sheet Deposits at depths of between 0.35m and 0.80mbgl. These extended to a maximum proven depth of 5.45mbgl.

6.6 The strata generally comprised brown, locally gravelly, fine to coarse sand. Gravel sized particles include sandstone and quartz.

6.7 Horizons of firm, brown, slightly silty, sand clay were encountered within WS1 and WS3 at depths of 3.25m and 3.40mbgl and were between 0.60m and 0.75m in thickness.

6.8 SPT 'N' values in the Glaciofluvial Sheet Deposits range between 10 and 28 indicating a medium dense state of compaction.

Visual/Olfactory Evidence of Contamination

6.9 No visual and/or olfactory evidence of significant ground contamination was identified within the exploratory holes during the investigation.

Groundwater

6.10 Groundwater was encountered during the formation of WS1 and WS3, within the Glaciofluvial strata at depths of 3.00mbgl.

6.11 The standpipes were noted to be dry during the subsequent monitoring.

6.12 It should be appreciated that the groundwater monitoring described above has been undertaken during a very short period of time. Significant variations in the long term groundwater regime may occur at other times, particularly with prolonged, extreme weather conditions, and that no account can be taken of such in this report.

General

6.13 It should also be appreciated that ground conditions may vary between and away from the exploratory hole positions, and that no account can be taken in this report of such variations.

7.0 GEOTECHNICAL APPRAISAL

Site Preparation and Earthworks

7.1 No demolition should proceed until an appropriate Asbestos survey of the existing building has been undertaken and any Asbestos Containing Materials (ACM) removed by an appropriately licensed contractor.

7.2 Ground obstructions in the form of existing foundations, ground floor slabs and other buried concrete obstructions should be anticipated and will need to be broken out to suitable depths below formation levels where they are to impinge on the proposed redevelopment.

7.3 Demolition materials, existing asphalt/concrete hardstanding and below ground foundations removed as part of the clearance work, subject to appropriate screening and crushing, may be suitable for re-use as bulk fill beneath hard cover areas.

7.4 It is anticipated that localised trees will need to be removed from around the perimeter of the site with some being retained. It is assumed that the current development configuration has been outlined in consideration of retained trees and specifically Root Protection Areas (RPA) as would need to be determined by the landscape architect.

7.5 Notwithstanding this, construction near retained trees and importantly within the RPA should be undertaken with due regard to guidance provided in BS5837:2012 'Trees in relation to design, demolition and construction – recommendations'.

7.6 Also, as part of the site clearance, the removal of trees and other vegetation should be undertaken under consultation with an ecological specialist.

7.7 Topsoil stripped from the area of redevelopment should be stockpiled and protected from inclement weather for future use in garden/landscaped areas subject to confirmatory laboratory testing.

7.8 Site enabling works will need to take account of the integrity of the existing services, including the gas governor, gas main and the adjacent highways.

7.9 No significant earthworks are anticipated to facilitate redevelopment of the site with the exception of localised re-grading.

7.10 It should be noted that the stopping-up and/or realignment of public footpaths will likely be subject to consultation with the local authority and/or Department of Transport. To this end, the status of the footpaths will need to be determined and time allowed within the development programme for all relevant applications, consultations and approvals.

Foundations

7.11 Any localised areas of Made Ground and incompetent natural strata should be considered unsuitable for the direct support of structural loads as their generally incompetent nature could result in unacceptable total and differential settlements.

7.12 Where the new structure is to be supported on traditional shallow spread foundations constructed within natural granular Glaciofluvial Sheet Deposits at depths of no less than 0.75m below existing ground level, such foundations should be designed on a net allowable bearing pressure not exceeding 125kN/m².

7.13 However, all formations will need to be carefully inspected to confirm the anticipated soil strength with any soft/loose or otherwise incompetent soils so encountered being excavated and replaced with foundation concrete.

7.14 Where higher structural loads are anticipated, the ground is likely to be suitable for ground improvement by vibro-compaction, although the vibration effects on nearby services and structures would need to be considered, in consultation with a specialist contractor, in this respect.

7.15 Alternatively, a piled foundation solution could be considered with piles being taken down through the Made Ground and Glaciofluvial Deposits and into the underlying Glacial Till which is anticipated to be within 10m of the surface regionally.

7.16 Should this solution be considered, a specialist piling contractor will need to be consulted with respect to the suitable pile type, size and depth although it is considered that noise and vibration effects may determine that a driven pile will not be appropriate.

7.17 Notwithstanding the above, foundation construction will need to take account of nearby services and, where they are in close proximity, may need to be taken down to beneath the lowest level of the service trench so that their structural integrity is maintained.

7.18 During excavation works, care should also be taken to avoid damage / undermining of existing structures and infrastructure such as to the gas governor and adjacent highways, with the provision of adequate support measures where considered appropriate.

7.19 The final foundation solution will need to be confirmed by further ground investigations once development proposals, including finished formation levels, have been finalised and ideally once the existing buildings have been vacated and demolished.

Floor Slabs

7.20 In view of the recorded thickness of Made Ground at the site, floor slabs may need to be suspended.

7.21 However, this should be reviewed once the development scheme, including finished floor levels, have been finalised.

Excavations and Groundwater

7.22 Excavations at the site should be feasible using an appropriate scale of hydraulic plant. All excavations at the site will require adequate lateral support, or battering back to a safe angle, to ensure their stability.

7.23 Perched groundwater inflows should be anticipated during excavations within the granular Glaciofluvial Sheet Deposits. Conventional 'sump and pump' dewatering measures are likely to be adequate to keep excavations dry although it cannot be discounted that groundwater exclusion measures such as interlocking sheet piles may be required in conjunction to prevent excessive ingress of water into deeper excavations.

7.24 Such support measures will also prevent 'running sand' conditions leading to loss of ground beneath nearby adjacent structures or infrastructure.

Pavement Design

7.25 In consideration of the ground conditions it is recommended that new road pavement construction design should be based on a California Bearing Ratio (CBR) value of no more than 3% in Made Ground and 5% within the granular Glaciofluvial Deposits.

7.26 The CBR would need to be reviewed and confirmed by site inspection and possibly in-situ testing at formation levels following any earthwork operations and prior to pavement construction.

Concrete Design

7.27 Design/mix of buried concrete should be undertaken in accordance with the "Aggressive Chemical Environment for Concrete" (ACEC) classification, of BRE Special Digest 1:2005 (Concrete in Aggressive Ground). With reference to the site history, it is deemed appropriate to classify the site as "Brownfield", with respect to BRE Special Digest.

7.28 Values of 2:1 water/soil extract for sulphate do not exceed 100mg/l. Values of pH range from 7.0 to 8.2 indicating near neutral to slightly alkaline conditions.

7.29 On the basis of these results, the typical design sulphate (DS) class and "Aggressive Chemical Environment for Concrete" (ACEC) class for the site are DS-1 and AC-1 respectively.

Drainage and Soakaways

7.30 In consideration of the site being underlain by relatively permeable Glaciofluvial Sheet Deposits, soakaways could be a feasible drainage option for the site. This will need to be confirmed by appropriate large scale infiltration testing at drainage design stage.

8.0 GENERIC QUANTITATIVE RISK ASSESSMENT (GQRA)

General

8.1 A review of the desk study information has concluded that, due to the absence of historic contaminative land use, the potential for a significant pollution linkage to be present at the site is low with corresponding low risk to human health and the environment.

8.2 Furthermore, no visual or olfactory evidence of significant ground contamination has been recorded in the intrusive investigations.

8.3 Notwithstanding this, it has been considered prudent to adopt a precautionary principal and undertake limited chemical analysis of the sub-surface soils to confirm the low human health risk status of the site.

Human Health

8.4 Selected samples have been analysed for a general suite of contaminants of concern and compared against Screening Levels (SL's) for human health to determine the significance of the measured concentrations in relation to the site conceptual model. Thus a Generic Quantitative Risk Assessment (GQRA) has been undertaken in line with guidelines provided in CLR11, Model Procedures for the Management of Land Contamination, 2004.

8.5 Criteria for a limited number of contaminants have been derived by DEFRA in their document entitled SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, April 2014.

8.6 Within the document, Category 4 Screening Levels (C4SL's) are described as being more pragmatic than previous screening criteria and represent concentrations in soil that present an 'acceptable' level of risk within the context of Part 2A.

8.7 The National Planning Policy Framework states that 'after development, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990'. Therefore by inference, the C4SL's are appropriate for use in the planning context.

8.8 Although the SP1010 document states that C4SL only apply for a 'sandy loam soil with 6% soil organic matter', it is generally accepted that assessment criteria for metals are not sensitive to changes in soil organic content (SOM). The C4SL's have therefore been adopted as assessment criteria in this report for the listed metals within the SP1010.

8.9 Further to this, LQM/CIEH published a revised document entitled 'The LQM/CIEH S4ULs for Human Health Risk Assessment' in 2015. In brief, the document provides updated assessment criteria which have been derived in accordance with UK legislation, national as well as EA policy and using a modified version of the CLEA software and available guidance. The new screening criteria, or Suitable 4 Use Levels (S4ULs), are intended to provide a complete and updated replacement to the previous LQM/CIEH GAC of 2009. As such they are considered appropriate for use in this assessment for other contaminants not covered by C4SL's and/or for organic contaminants assuming a worst case Soil Organic Matter (SOM) of 1% as an initial conservative assessment.

8.10 For each contaminant, S4UL's and C4SL's have been calculated for six land use scenarios, namely:

- Residential with homegrown produce.
- Residential without homegrown produce.
- Allotments.
- Commercial.
- Public Open Space near residential housing.
- Public Parks (remote from residential housing).

8.11 In light of the proposed development, Screening Levels (SLs) for a "Residential without Homegrown Produce" end-use are considered appropriate for assessment at this stage.

8.12 A table of relevant SLs protective of human health is provided in Appendix 05.

Soil Test Results

8.13 6no samples of Made Ground were analysed for a suite of Metals, Semi-Metals and PAH's. The majority of the concentrations measured were below the SL's with exceptions as outlined in the table below.

Contaminant	Number of Exceedances	SL (mg/kg)	Recorded Concentrations (mg/kg)	Samples
Benzo[a]Pyrene	1	3.2	7.3	HP1 – 0.50m
Benzo[b]Fluoranthene	1	3.9	7.2	HP1 – 0.50m
Dibenz[a,h]Anthracene	3	0.31	0.32 – 1.7	HP1 – 0.50m HP2 – 0.20m WS1 – 0.20m

8.14 No asbestos fibres were detected in any of the samples analysed.

Conclusions

8.15 In consideration of the chemical test results it is concluded that the site does not contain significant and/or widespread contamination. However, samples of Made Ground were found to contain localised elevated concentrations of PAH, namely benzo[a]pyrene, benzo[b]fluoranthene and dibenz[a,h]anthracene above the relevant SLs. Such contamination is likely to be attributed to localised fragments of ash within the sample matrix.

8.16 As the majority of the site will be covered with buildings and hardstanding, there will be no mechanism for long-term direct contact with such contaminants. Therefore the risk to the end-user and to the general public will be negligible.

8.17 However, a direct contact pollution linkage could be envisaged in any new landscaped areas and it is recommended that Made Ground exposed at the surface in such areas is removed or is covered by clean sub-soil and topsoil thus removing the pollution linkage. This will normally comprise a 300mm cover of clean imported topsoil over the existing Made Ground.

8.18 However, where the Made Ground is currently less than 300mm thick, it may be more appropriate to excavate and remove it to expose the underlying natural soils prior to placement of a suitable thickness of sub-soil/topsoil.

8.19 The nature of the contaminants encountered is such that they are not considered to be volatile and hence be a potential risk to human health through inhalation of indoor or outdoor air. No specific requirements are therefore recommended in this respect.

9.0 GROUND GAS RISK ASSESSMENT

Methodology

9.1 Current guidance for the assessment of risk associated with the presence of hazardous ground gases (principally methane and carbon dioxide) is provided in two key documents, namely:

- Code of practice for the Characterisation and remediation from Ground Gas in Affected Developments. British Standard Institution (BS 8485: 2015); and
- Assessing Risks posed by Hazardous Ground Gases to Buildings CIRIA (C665, 2007).

9.2 The assessment presented herein is primarily based on the BS8485 document.

9.3 Hazardous ground gas qualitative risk assessment is based on a conceptual model similar to that used for soil and groundwater contamination sources (i.e., source-pathway-receptor pollutant linkages). A semi-quantitative estimate of risk can be assessed based on knowledge of the conceptual model and a measure of hazardous gas concentration and gas flow at the site within monitoring standpipes.

9.4 Based on the measured flow rates and hazardous gas concentrations, individual "hazardous gas flow rates" (Q_{hg}) can be derived for each monitoring point, from which the "site characteristic hazardous gas flow rate" (Q_{hgs}), and then the "Characteristic Situation" (CS) can be determined.

9.5 BS8485 provides guidance on the level of gas protection requirements based upon the characteristic situation and the proposed development based on building type as outlined in Table 3.

Table 3 - Building Types

	Type A	Type B	Type C	Type D
Ownership	Private	Private or commercial/ Public, possible multiple	Commercial / Public	Commercial / Industrial
Control (Change of use)	None	Some but not all	Full	Full
Room Sizes	Small	Small/medium	Small to Large	Large Industrial/ Retail Park

9.6 The proposed development is indicated to comprise the construction of **Type A** buildings, the definition of which is provided in BS8485:2015 as:

- "Private ownership with no building management controls on alterations to the internal structure, the use of rooms, the ventilation of rooms or the structural fabric of the building. Some small rooms present. Probably conventional building construction (rather than civil engineering). Examples include private housing and some retail premises."

Ground Gas Conceptual Model

9.7 The site is not in an area recorded as being affected by naturally occurring radon gas.

9.8 There are no recorded active non-operational landfills within 1km of the subject site although the Environment Agency records a former waste destructor and its associated waste heaps at Nell Lane, some 18m south-west. As the waste was temporarily stockpiled prior to being burnt rather than landfilled, the former facility is not considered a significant source of ongoing ground gas generation and will therefore not affect the site.

9.9 The underlying geology does not include shallow coal seams which could have the potential to release hazardous ground gas.

9.10 Ground investigations have confirmed that no areas of relatively deep Made Ground or organic soils, with the potential to generate hazardous concentrations and volumes of ground gas, occur beneath the site.

9.11 In consideration of the above, the preliminary risk to the development from ground gas has been assessed as low. However, it has been considered prudent to undertake ground gas monitoring, primarily for methane and carbon dioxide, with associated flow rates, on one occasion, to date, on 3rd August 2016.

Results and Recommendations

9.12 The results to date indicate no detectable concentrations of methane with a maximum recorded carbon dioxide concentration of 5.9% by volume in air (v/v). No detectable ground gas flows have been recorded during the initial monitoring visits.

9.13 The results give a maximum Qhg value of <0.0059l/hr which indicates the site to classify as Characteristic Situation (CS) 1 – Very Low Gas Risk' in accordance with BS8485:2015, with no specific gas protection measures required.

9.14 However, due to the slightly elevated level of carbon dioxide measured in one standpipe, it may be prudent at this stage to allow for basic gas protection measures such as a lapped and taped gas membrane, taken over cavity walls and sealed at slab penetrations, together with under-floor ventilation of 'Very Good performance' as described in BS8485.

9.15 This will need to be confirmed on completion of the remaining ground gas monitoring and further gas risk assessment in due course.

9.16 This should also be confirmed with the local authority Environmental Health / Building Control Officer prior to any building design being finalised.

10.0 OTHER POTENTIAL DEVELOPMENT CONSIDERATIONS

Excavated Soils

10.1 Groundworks undertaken during the development will produce excavated soil which will require appropriate site management. Principally, and in line with the sustainable development agenda, any soils arising from site excavations should firstly be considered for re-use where possible by incorporation into the development.

10.2 Site-won granular Made Ground may be reused as bulk fill, subject to engineering suitability, under proposed hardstanding areas.

10.3 Waste arisings comprising uncontaminated natural soil would be suitable, subject to confirmatory analysis, for re-use as bulk fill or as sub-soil within any planned garden and landscaped areas.

10.4 Topsoil removed as part of the surface strip will be suitable for re-use provided it is removed in a controlled manner to avoid mixing with underlying materials and is subject to further analysis to confirm its suitability.

10.5 Where soils are surplus to requirements, they will need to be removed from site through appropriate waste management.

10.6 It should be noted that the chemical analysis results for disposal classification are assessed against different assessment criteria to those relating to contamination risk assessment. Soils that are deemed suitable for use in terms of risk to human health and the environment may not necessary be un-contaminated and could be classified as Non-Hazardous or even Hazardous for disposal purposes.

10.7 For guidance and based on the current information, it is likely that the majority of Made Ground would be classified as 'Non-Hazardous' with natural soils classified as 'Inert' for landfill disposal.

10.8 Notwithstanding this, it will be the responsibility of the waste producer to undertake testing and classification of any waste soils for disposal to an appropriately licenced landfill in accordance with current guidelines and Duty of Care requirements.

Imported Fill

10.9 Imported fill will be subject to specific quality requirements. Allowance should be made for testing imported fill materials prior to emplacement to ensure suitability.

Water Supply Pipes

10.10 The water supplier will need to be consulted with regards the selection of suitable water supply pipe materials for the development. However, in light of the ground conditions encountered, the requirement for specific materials and measures to protect the water supply from ground contamination is not envisaged at this stage.

APPENDIX 01

Drawings

jda architects

930 Arrowfield

PS008 Proposed Site Plan 1:200



N

perimeter railings @ 1800mm

perimeter railings @ 1500mm with defensible planting

close board fencing @ 1800mm

Accommodation Schedule

19no. 2B3P (61m2)
5no. 2B4P (75m2)
24 Total

Parking

36 number parking spaces
6 number visitor spaces
5 number Nell Lane spaces

Site Boundary



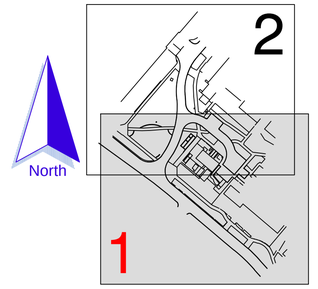
Arrowfield Road

Buckthorn Close

Nell Lane

Notes

All Dimensions to be checked on site. Walls shown on plans are not to be assumed to be solid & should be checked for thickness, construction, load bearing capacity & stability.



0 2 4 6 8 10 12 14 16 18 20
Metres

ABBREVIATIONS

BOL	Bollard
BT	BT Cover
CATV	Cable TV Cover
CB	Control Box
CH	Cable Height
CL	Cover Level
DK	Drop Kerb
EH	Eaves Height
FH	Fire Hydrant
GV	Gas Valve
GU	Gully
IC	Inspection Cover
LP	Lamp Post
MH	Man Hole
RH	Ridge/Roof Height
RWP	Rain Water Pipe
SP	Sign Post
TC	TriCAD Control
TF	Top of Fence
TL	Threshold Level
TP	Telegraph Pole
TH	Top of Hedge
TW	Top of Wall
WP	Waste Pipe
WV	Water Valve

NOTE

All levels and coordinates relate to OSGB36(15) using GNSS data.

Levels defining edge of carriageway are observed at channel (bottom of kerb).

Rev.0 Description. Issued

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Buckthorn Close
Manchester

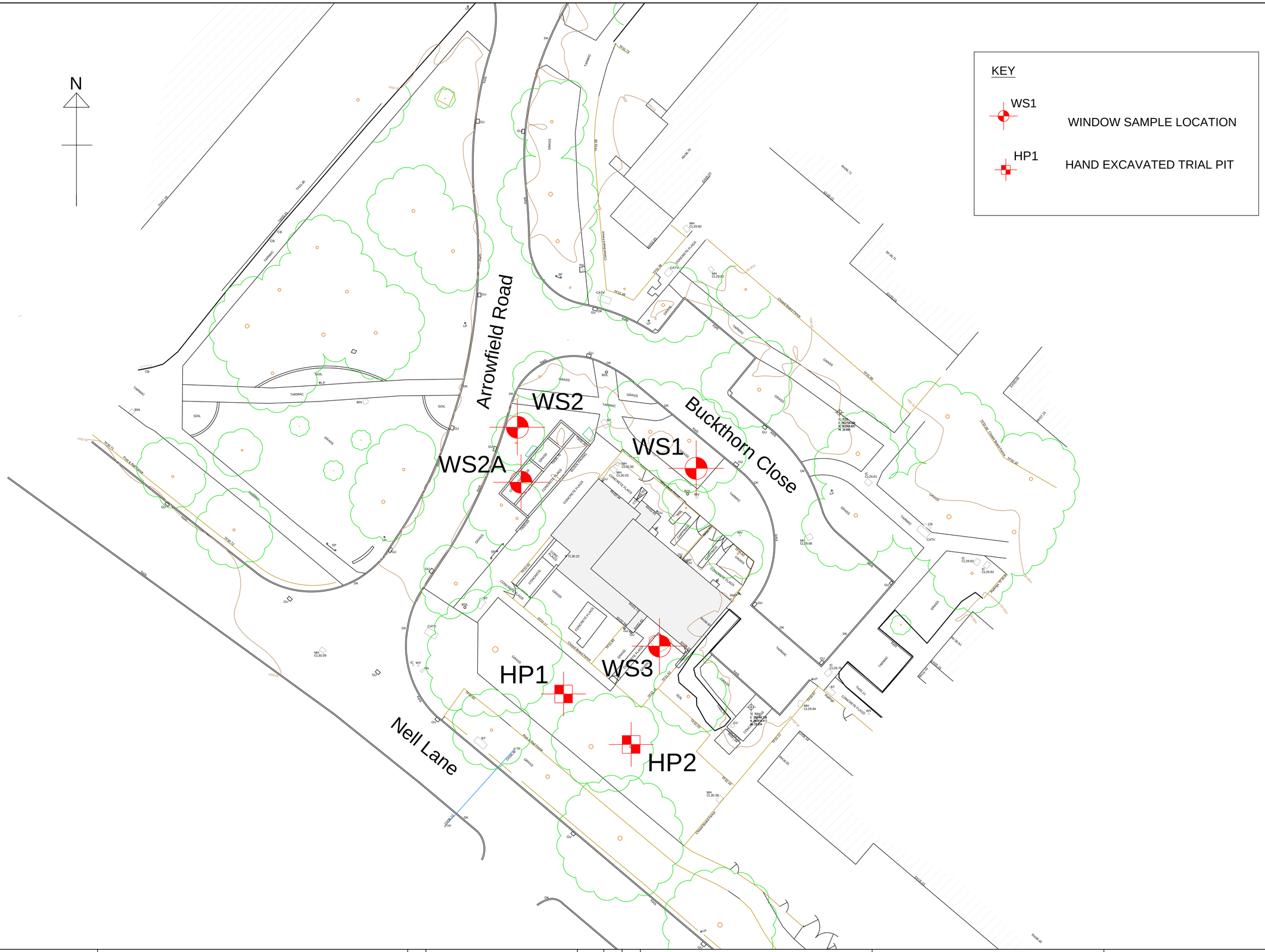
Project Description
Site Survey

Drawing Title
Existing Site Layout

Scale	Date	Drawn By
1:200@A1	14/02/2017	AD

Drawing Number
TRI-1914-01

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Rev.	Amendment	Date	By	Chkd
-	FINAL	18-07-17	SCS	PGD

Project
ARROWFIELD ROAD, FLIXTON

Status
FINAL

CLIENT
SOUTHWAY HOUSING TRUST

Title
EXPLORATORY HOLE LOCATION PLAN

Drawn	Checked	Date	Scale
SCS	PGD	18/07/17	1:200@A1

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Job No. 7592G

Drawing No. SK-01

APPENDIX 02

Exploratory Hole Records

WML CONSULTING	Project Title: Arrowfield Road		HP1
	Project Number: 7592G	Client: Southway Housing Trust	Sheet 1 Of 1
	GL (mAOD):	N Coord: 0	E Coord: 0
Date: 31/05/2017	Method: Hand Dug	Driller: LOT Geotechnics	Logged By: TPB

Depth (m)	Type	Test Result	Level	Legend	Depth (m)	Description	Water	Standpipe
0.50	J					Turf over dark brown, slightly silty, slightly gravelly SAND with occasional rootlets. Gravel is subangular, fine to coarse, including brick, tarmac, sandstone and ash. (MADE GROUND)		
					1.00			
					1.20	End Of Borehole At 1.20 m		
					2.00			
					3.00			
					4.00			
					5.00			
					6.00			

KEY

D - Disturbed Sample
B - Bulk Sample
U - Undisturbed
W - Water Sample
S - Standard Penetration Test
C - Cone Penetration Test
N - Penetration Test 'N' Value
V - Hand Shear Vane kPa
▽ - Groundwater Strike
▼ - Groundwater Level

AGS

REMARKS

No Groundwater Encountered

Scale: 1:40

Water Strikes

Date	Strike	Level	Minutes	Casing	Sealed

Daily Log Of Depths

Date	Casing	Water

Chiselling

From	To	Hours

Printed By GeoLogs (www.GeoLogs.com)

WML CONSULTING	Project Title: Arrowfield Road		HP2
	Project Number: 7592G	Client: Southway Housing Trust	Sheet 1 Of 1
	GL (mAOD):	N Coord: 0	E Coord: 0
Date: 31/05/2017	Method: Hand Dug	Driller: LOT Geotechnics	Logged By: TPB

Depth (m)	Type	Test Result	Level	Legend	Depth (m)	Description	Water	Standpipe
0.20	J				0.80	Turf over dark brown, slightly silty, slightly gravelly SAND with occasional rootlets. Gravel is subangular, fine to coarse, including brick, tarmac, sandstone and ash. (MADE GROUND)		
					1.00	Brown, fine to medium SAND. (GLACIOFLUVIAL DEPOSITS)		
					1.20	End Of Borehole At 1.20 m		
					2.00			
					3.00			
					4.00			
					5.00			
					6.00			

KEY

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C - Cone Penetration Test
N - Penetration Test 'N' Value
V - Hand Shear Vane kPa
▽ - Groundwater Strike
▼ - Groundwater Level

REMARKS

No Groundwater Encountered

Scale: 1:40

Water Strikes

Date	Strike	Level	Minutes	Casing	Sealed

Daily Log Of Depths

Date	Casing	Water

Chiselling

From	To	Hours

Printed By GeoLogs (www.GeoLogs.com)

WML CONSULTING	Project Title: Arrowfield Road		WS1
	Project Number: 7592G	Client: Southway Housing Trust	Sheet 1 Of 1
	GL (mAOD):	N Coord: 0	E Coord: 0
Date: 31/05/2017	Method: Window Sample	Driller: LOT Geotechnics	Logged By: TPB

Depth (m)	Type	Test Result	Level	Legend	Depth (m)	Description	Water	Standpipe
0.20	J				0.70	Turf over brown, slightly silty, slightly gravelly SAND with occasional rootlets. Gravel is subangular, fine to coarse, including brick. (MADE GROUND)		
1.20	J	N=14			1.00	Medium dense, brown, medium and coarse SAND. (GLACIOFLUVIAL DEPOSITS)		
		N=13			2.00			
		N=10			3.00		▼	
3.50	D				3.25	Firm, brown, slightly silty, sandy CLAY. (GLACIOFLUVIAL DEPOSITS)		
		N=11			4.00	Medium dense, brown, slightly gravelly, coarse SAND. Gravel is subrounded, fine, including sandstone and quartz. (GLACIOFLUVIAL DEPOSITS)		
		N=26			5.00			
					5.45	End Of Borehole At 5.45 m		
					6.00			

KEY

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C - Cone Penetration Test
N - Penetration Test 'N' Value
V - Hand Shear Vane kPa
▽ - Groundwater Strike
▼ - Groundwater Level

AGS

REMARKS

Hole collapsing to 2.70mbgl.

Scale: 1:40

Water Strikes

Date	Strike	Level	Minutes	Casing	Sealed
01/06/2017	3				

Daily Log Of Depths

Date	Casing	Water

Chiselling

From	To	Hours

Printed By GeoLogs (www.GeoLogs.com)

WML CONSULTING	Project Title: Arrowfield Road		WS2
	Project Number: 7592G	Client: Southway Housing Trust	Sheet 1 Of 1
	GL (mAOD):	N Coord: 0	E Coord: 0
Date: 31/05/2017	Method: Window Sample	Driller: LOT Geotechnics	Logged By: TPB

Depth (m)	Type	Test Result	Level	Legend	Depth (m)	Description	Water	Standpipe
0.40	J				0.70	Turf over brown, slightly silty, slightly gravelly SAND with occasional rootlets. Gravel is subangular, fine to coarse, including brick, sandstone and ash. (MADE GROUND)		
					1.00	Brown, fine to coarse SAND. (GLACIOFLUVIAL DEPOSITS)		
					1.30	End Of Borehole At 1.30 m		
					2.00			
					3.00			
					4.00			
					5.00			
					6.00			

KEY

D - Disturbed Sample
B - Bulk Sample
U - Undisturbed
W - Water Sample
S - Standard Penetration Test
C - Cone Penetration Test
N - Penetration Test 'N' Value
V - Hand Shear Vane kPa
▽ - Groundwater Strike
▼ - Groundwater Level

AGS

REMARKS

No Groundwater Encountered
Hole terminated at 1.30mbgl
due to potential services.

Scale: 1:40

Water Strikes

Date	Strike	Level	Minutes	Casing	Sealed

Daily Log Of Depths

Date	Casing	Water

Chiselling

From	To	Hours

Printed By GeoLogs (www.GeoLogs.com)

WML CONSULTING	Project Title: Arrowfield Road		WS2A
	Project Number: 7592G	Client: Southway Housing Trust	Sheet 1 Of 1
	GL (mAOD):	N Coord: 0	E Coord: 0
Date: 31/05/2017	Method: Window Sample	Driller: LOT Geotechnics	Logged By: TPB

Depth (m)	Type	Test Result	Level	Legend	Depth (m)	Description	Water	Standpipe
0.40	J				0.35	CONCRETE paving slab. (MADE GROUND)		
					1.00	Grey, slightly gravelly, fine to coarse SAND. Gravel is subangular, fine to coarse, including ash and clinker. (MADE GROUND)		
					1.20	Brown, fine to coarse SAND. (GLACIOFLUVIAL DEPOSITS)		
					2.00	End Of Borehole At 1.20 m		
					3.00			
					4.00			
					5.00			
					6.00			

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S - Standard Penetration Test
C - Cone Penetration Test
N - Penetration Test 'N' Value
V - Hand Shear Vane kPa
▽ - Groundwater Strike
▼ - Groundwater Level

AGS

REMARKS

No Groundwater Encountered
Hole terminated at 1.20mbgl
due to potential services.

Scale: 1:40

Water Strikes

Date	Strike	Level	Minutes	Casing	Sealed

Daily Log Of Depths

Date	Casing	Water

Chiselling

From	To	Hours

Printed By GeoLogs (www.GeoLogs.com)

WML CONSULTING	Project Title: Arrowfield Road		WS3
	Project Number: 7592G	Client: Southway Housing Trust	Sheet 1 Of 1
	GL (mAOD):	N Coord: 0	E Coord: 0
Date: 31/05/2017	Method: Window Sample	Driller: LOT Geotechnics	Logged By: TPB

Depth (m)	Type	Test Result	Level	Legend	Depth (m)	Description	Water	Standpipe
0.30	J				0.15	CONCRETE paving slab. (MADE GROUND)		
					0.60	Grey, medium SAND. (MADE GROUND)		
1.00	J	N=23			1.00	Brown, gravelly, fine to coarse SAND. Gravel is subangular, fine to coarse including brick. (MADE GROUND)		
		N=28			2.00	Medium dense, brown, fine to coarse SAND. (GLACIOFLUVIAL DEPOSITS)		
		N=13			3.00			
3.70	D	N=16			3.40	Firm, brown, slightly silty, sandy CLAY. (GLACIOFLUVIAL DEPOSITS)		
		N=16			4.00	Medium dense, brown, slightly gravelly, medium and coarse SAND. Gravel is subrounded, fine, including sandstone and quartz. (GLACIOFLUVIAL DEPOSITS)		
					5.00			
					5.45	End Of Borehole At 5.45 m		
					6.00			

KEY

D - Disturbed Sample
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S - Standard Penetration Test
C - Cone Penetration Test
N - Penetration Test 'N' Value
V - Hand Shear Vane kPa
▽ - Groundwater Strike
▼ - Groundwater Level

AGS

REMARKS

Hole collapsing to 2.60mbgl.

Scale: 1:40

Water Strikes

Date	Strike	Level	Minutes	Casing	Sealed
01/06/2017	3				

Daily Log Of Depths

Date	Casing	Water

Chiselling

From	To	Hours

Printed By GeoLogs (www.GeoLogs.com)

APPENDIX 03

Chemical Analytical Results

CONCEPT LIFE SCIENCES
DELIVERING SCIENCE

Concept Life Sciences is a trading name of Scientific Analysis Laboratories registered in England and Wales (No 2514788)

Concept Life Sciences

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 658257-1

Date of Report: 13-Jun-2017

Customer: WML Consulting Ltd
8 Oak Green Earl Road
Stanley Green Business Park
Cheadle Hulme
Cheshire
SK8 6QL

Customer Contact: Ms Sam Seddon

Customer Job Reference: 7592G
Customer Purchase Order: SO00040
Customer Site Reference: Arrowfield Rd
Date Job Received at Concept: 02-Jun-2017
Date Analysis Started: 05-Jun-2017
Date Analysis Completed: 13-Jun-2017

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with Concept SOPs

UKAS TESTING
1549

Report checked
and authorised by :
Aneta Dybek-Echtermeyer
Project Manager

Issued by :
Aneta Dybek-Echtermeyer
Project Manager

Concept Reference: 658257
Project Site: Arrowfield Rd
Customer Reference: 7592G

Soil Analysed as Soil
WML Basic Suite

				Concept Reference	**658257 001**	**658257 003**	**658257 004**	**658257 006**	**658257 008**
				Customer Sample Reference	**WS1**	**WS2**	**WS2A**	**WS3**	**HP1**
				Depth	**0.20**	**0.40**	**0.20**	**0.30**	**0.50**
				Date Sampled	**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Asbestos ID	T27	AR			N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic	T6	A40	1	mg/kg	**10**	**9**	**11**	**10**	**19**
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	T6	A40	1	mg/kg	<1	<1	<1	<1	<1
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Copper	T6	A40	1	mg/kg	**29**	**27**	**54**	**30**	**72**
Lead	T6	A40	1	mg/kg	**81**	**64**	**10**	**120**	**200**
Mercury	T6	A40	1	mg/kg	<1	<1	<1	<1	<1
Nickel	T6	A40	1	mg/kg	**11**	**12**	**27**	**14**	**18**
Selenium	T6	A40	3	mg/kg	<3	<3	<3	<3	<3
Vanadium	T6	A40	1	mg/kg	**15**	**14**	**27**	**24**	**23**
Zinc	T6	A40	1	mg/kg	**48**	**43**	**23**	**91**	**100**
Cyanide(Total)	T4	AR	1	mg/kg	<1	<1	<1	<1	<1
SO4(2:1)	T6	AR	0.1	g/l	<0.1	<0.1	<0.1	<0.1	<0.1
Sulphur (total)	T6	A40	0.01	%	**0.02**	**0.02**	**0.04**	**0.03**	**0.03**
pH	T7	A40			**7.5**	**7.6**	**7.4**	**8.2**	**7.7**
Phenols(Mono)	T4	AR	1	mg/kg	<1	<1	<1	<1	<1
Soil Organic Matter	T287	A40	0.1	%	**3.9**	**3.0**	**7.9**	**2.5**	**6.2**

Concept Reference: 658257
Project Site: Arrowfield Rd
Customer Reference: 7592G

Soil Analysed as Soil
WML Basic Suite

				Concept Reference	**658257 009**
				Customer Sample Reference	**HP2**
				Depth	**0.20**
				Date Sampled	**01-JUN-2017**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**	
Asbestos ID	T27	AR			N.D.
Arsenic	T6	A40	1	mg/kg	**18**
Boron (water-soluble)	T6	AR	1	mg/kg	<1
Cadmium	T6	A40	1	mg/kg	<1
Chromium VI	T6	AR	1	mg/kg	<1
Copper	T6	A40	1	mg/kg	**63**
Lead	T6	A40	1	mg/kg	**190**
Mercury	T6	A40	1	mg/kg	<1
Nickel	T6	A40	1	mg/kg	**18**
Selenium	T6	A40	3	mg/kg	<3
Vanadium	T6	A40	1	mg/kg	**23**
Zinc	T6	A40	1	mg/kg	**94**
Cyanide(Total)	T4	AR	1	mg/kg	<1
SO4(2:1)	T6	AR	0.1	g/l	<0.1
Sulphur (total)	T6	A40	0.01	%	**0.03**
pH	T7	A40			**7.0**
Phenols(Mono)	T4	AR	1	mg/kg	<1
Soil Organic Matter	T287	A40	0.1	%	**6.4**

Concept Reference: 658257
Project Site: Arrowfield Rd
Customer Reference: 7592G

Soil Analysed as Soil
Miscellaneous

Concept Reference	**658257 002**	**658257 005**	**658257 007**
Customer Sample Reference	**WS1**	**WS2A**	**WS3**
Depth	**1.20**	**1.00**	**1.00**
Date Sampled	**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**

Determinand	Method	Test Sample	LOD	Units			
SO4(2:1)	T6	AR	0.1	g/l	<0.1	<0.1	<0.1

Concept Reference: 658257
Project Site: Arrowfield Rd
Customer Reference: 7592G

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

Concept Reference					**658257 001**	**658257 003**	**658257 004**	**658257 006**	**658257 008**
Customer Sample Reference					**WS1**	**WS2**	**WS2A**	**WS3**	**HP1**
Depth					**0.20**	**0.40**	**0.20**	**0.30**	**0.50**
Date Sampled					**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**	**01-JUN-2017**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T149	AR	0.01	mg/kg	**0.27**	(9) <0.10	**0.01**	**0.03**	**0.38**
Acenaphthylene	T149	AR	0.01	mg/kg	**0.32**	(9) <0.10	<0.01	**0.01**	**0.32**
Acenaphthene	T149	AR	0.01	mg/kg	**0.30**	(9) <0.10	<0.01	**0.02**	**1.2**
Fluorene	T149	AR	0.01	mg/kg	**0.69**	(9) <0.10	<0.01	**0.01**	**0.92**
Phenanthrene	T149	AR	0.01	mg/kg	**3.7**	**0.50**	**0.03**	**0.18**	**6.8**
Anthracene	T149	AR	0.01	mg/kg	**0.84**	**0.13**	**0.01**	**0.04**	**2.1**
Fluoranthene	T149	AR	0.01	mg/kg	**3.3**	**1.2**	**0.04**	**0.44**	**15**
Pyrene	T149	AR	0.01	mg/kg	**3.2**	**1.1**	**0.04**	**0.43**	**13**
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	**1.7**	**0.54**	**0.03**	**0.23**	**7.5**
Chrysene	T149	AR	0.01	mg/kg	**1.7**	**0.63**	**0.03**	**0.25**	**7.7**
Benzo(b)fluoranthene	T149	AR	0.01	mg/kg	**1.5**	**0.60**	**0.03**	**0.26**	**7.2**
Benzo(k)fluoranthene	T149	AR	0.01	mg/kg	**1.1**	**0.57**	**0.04**	**0.18**	**5.8**
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	**1.5**	**0.54**	**0.02**	**0.19**	**7.3**
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	**0.72**	**0.35**	**0.02**	**0.12**	**4.0**
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	**0.32**	**0.14**	**0.01**	**0.05**	**1.7**
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	**0.84**	**0.43**	**0.02**	**0.14**	**4.4**
PAH(total)	T149	AR	0.01	mg/kg	**22**	**6.7**	**0.33**	**2.6**	**85**

Concept Reference: 658257
Project Site: Arrowfield Rd
Customer Reference: 7592G

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

Concept Reference	**658257 009**
Customer Sample Reference	**HP2**
Depth	**0.20**
Date Sampled	**01-JUN-2017**

Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T149	AR	0.01	mg/kg	**0.14**
Acenaphthylene	T149	AR	0.01	mg/kg	**0.11**
Acenaphthene	T149	AR	0.01	mg/kg	**0.34**
Fluorene	T149	AR	0.01	mg/kg	**0.24**
Phenanthrene	T149	AR	0.01	mg/kg	**2.7**
Anthracene	T149	AR	0.01	mg/kg	**0.68**
Fluoranthene	T149	AR	0.01	mg/kg	**6.2**
Pyrene	T149	AR	0.01	mg/kg	**5.7**
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	**3.0**
Chrysene	T149	AR	0.01	mg/kg	**3.2**
Benzo(b)fluoranthene	T149	AR	0.01	mg/kg	**2.9**
Benzo(k)fluoranthene	T149	AR	0.01	mg/kg	**3.0**
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	**3.0**
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	**1.8**
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	**0.70**
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	**2.1**
PAH(total)	T149	AR	0.01	mg/kg	**36**

Index to symbols used in 658257-1

Value	Description
A40	Assisted dried < 40C
AR	As Received
N.D.	Not Detected
9	LOD raised due to dilution of sample
S	Analysis was subcontracted
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T27	PLM
T6	ICP/OES
T149	GC/MS (SIR)
T287	Calc TOC/0.58
T4	Colorimetry
T7	Probe

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Asbestos ID	T27	AR			SU	001,003-004,006,008-009
Arsenic	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Boron (water-soluble)	T6	AR	1	mg/kg	N	001,003-004,006,008-009
Cadmium	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Chromium VI	T6	AR	1	mg/kg	N	001,003-004,006,008-009
Copper	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Lead	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Mercury	T6	A40	1	mg/kg	U	001,003-004,006,008-009

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Nickel	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Selenium	T6	A40	3	mg/kg	U	001,003-004,006,008-009
Vanadium	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Zinc	T6	A40	1	mg/kg	U	001,003-004,006,008-009
Cyanide(Total)	T4	AR	1	mg/kg	U	001,003-004,006,008-009
SO4(2:1)	T6	AR	0.1	g/l	N	001-009
Sulphur (total)	T6	A40	0.01	%	N	001,003-004,006,008-009
pH	T7	A40			U	001,003-004,006,008-009
Phenols(Mono)	T4	AR	1	mg/kg	U	001,003-004,006,008-009
Soil Organic Matter	T287	A40	0.1	%	N	001,003-004,006,008-009
Naphthalene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Acenaphthylene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Acenaphthene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Fluorene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Phenanthrene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Anthracene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Fluoranthene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Pyrene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Chrysene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Benzo(b)fluoranthene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Benzo(k)fluoranthene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009
PAH(total)	T149	AR	0.01	mg/kg	U	001,003-004,006,008-009

APPENDIX 04

Gas and Groundwater Monitoring

Gas & Groundwater Monitoring Record Sheet

WML CONSULTING

Project Name:- Arrowfield Road
Project No:- 7592G
Client:- Southway Devco Ltd

Date:- 03/08/2017
Start Time:- 11:30
End Time:- 12:00

Atmospheric Pressure
Start:- 996mb
End:- 996mb

Trend:- Rising

Instrument:- Gas Data GFM436

Operator:- TPB

Hole ID	Flow l/hr	DP	CH4		CO2		Min O2 %	Peak H2S ppm	Peak CO ppm	Hexane %	Water Level mbgl	Base of Hole mbgl
			Peak	GSV l/hr	Peak	GSV l/hr						
HP1	<0.1	0	0.0	0.0000	1.9	0.0019	19.6	0	0	0.0	Dry	1.20
WS1	<0.1	0	0.0	0.0000	5.9	0.0059	14.8	0	0	0.0	Dry	2.70
WS3	<0.1	0	0.0	0.0000	2.9	0.0029	18.6	0	0	0.0	Dry	2.70

Additional Comments

APPENDIX 05

Screening Levels

Site Specific Assessment Criteria for Residential (without homegrown produce) based on 1% SOM

Contaminant	Criteria for 6% SOM (mg/kg)
Metals	
Arsenic	40
Boron	11000
Cadmium	85
Chromium III	910
Chromium VI	6
Copper	7100
Lead*	310
Mercury	1.2
Nickel	180
Selenium	430
Vanadium	1200
Zinc	40000
Non – Metals	
Phenol	440^{dir} (460)
Polyaromatic Hydrocarbons (PAH) 1% SOM	
Benz[a]anthracene	11
Benzo[a]pyrene	3.2
Benzo[b]fluoranthene	3.9
Benzo[ghi]perylene	360
Benzo[k]fluoranthene	110
Chrysene	30
Dibenz[ah]anthracene	0.31
Fluoranthene	1500
Indeno[123-cd]pyrene	45
Naphthalene	2.3
Pyrene	3700

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* Criteria for a limited number of contaminants have been derived by DEFRA in their document entitled SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, April 2014.

Contaminant	Criteria (mg/kg)
Volatile Organic Compounds – (VOCs) 1% SOM	
Benzene	0.38
Ethylbenzene	83
Toluene	880[vap](869)
Xylene	79
1,2-Dichloroethane	0.0092
1,1,1-Trichloroethane	9.0
Tetrachloroethane	3.9
Tetrachloroethene (PCE)	0.18
Tetrachloromethane	0.026
Trichloroethene (TCE)	0.017
Trichloromethane	1.2
Vinyl Chloride	0.00077
Semi-Volatile Organic Compounds (SVOCs) 1% SOM	
1,2-Dichlorobenzene	24
1,4-Dichlorobenzene	61
1,2,4-Trichlorobenzene	2.6
Hexachlorobenzene	4.1(0.2)[vap]
Total Petroleum Hydrocarbons – TPH	
Aliphatic C5-6	42
Aliphatic C6-8	100
Aliphatic C8-10	27
Aliphatic C10-12	130(48)[vap]
Aliphatic C12-16	1100(24)[sol]
Aliphatic C16-35	65,000(8.48)[sol]
Aliphatic C35 - 44	65,000(8.84)[sol]
Aromatic C5 – 7 (benzene)	370
Aromatic C7 – 8 (toluene)	860
Aromatic C8-10	47
Aromatic C10-12	250
Aromatic C12-16	1800
Aromatic C16-21	1900
Aromatic C21-35	1900
Aromatic C35 - 44	1900

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