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# McCARTHY AND STONE RETIREMENT LIFESTYLES LTD

# LAND ADJACENT TO SERPENTINE ROAD

# CLECKHEATON

# KIRKLEES

# WEST YORKSHIRE

# BD19 3NA

**Arc Project No: 16-075**

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Date: 31st March 2016

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Date: 31st March 2016

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## Appendices

## EXECUTIVE SUMMARY

As requested by McCarthy & Stone Retirement Lifestyles Limited, and in conjunction with the Phase 1: Desk Top Study Report (DTS) completed for this site (Ref. No. 16-075, March 2016), Phase 2: Ground Investigation works have been carried out adjacent to Serpentine Road, Cleckheaton, in West Yorkshire, where it is proposed to redevelop the site with mixed use including a new retirement and assisted living accommodation, a care home and a series of private residential town houses with associated car parking, hardstanding and soft landscaped areas. The site was previously occupied by Albion Iron Works, Northgate Mills and Tofts Shed. Former uses included animal feed compounding, weaving works, garage services and car dealers.

### Ground Investigation Works

The intrusive investigation works comprised 17 no. machine excavated trial pits (TP's 01 to 17). The above exploratory positions of which can be seen on a copy of the Exploratory Hole Location Plan, attached in Appendix II.

### Ground Conditions

Made ground was identified across the site to depths of between c.0.10m and c.3.70m. Made ground generally included an initial surfacing of tarmac, concrete or gravel overlying an ashy sand material which typically included bricks, fragments of concrete with red shale and slag recorded locally.

Superficial drift deposits were absent onsite.

Solid sandstone and siltstone deposits (Lower Coal Measures) were encountered in the trial pits immediately below the made ground materials. The siltstone and sandstone was generally recorded as initially completely weathered. The completely weathered siltstone was recorded as a 'clay type' material, and was generally 'firm' in nature. Below the completely weathered zone, the trial pits extended into more competent solid deposits.

In the north western area of the site, shallow intact 'brown' coal was encountered at depths of between c.1.40m to c.2.00m (TP01) and c.0.45m and c.1.20m (TP03).

### Foundations

When considering the ground conditions, a combination of traditional strip footings, deep strip and trench fill foundations complimented with pad foundations would be suitable for the various proposed structures.

### Contamination

The Level 1 Risk Assessments have been considered for two separate end-uses; 'Residential without homegrown produce' targeting the central and western developments, and 'Residential with homegrown produce' end-use for the proposed town houses to the east.

From the results of the contamination screening carried out and the Level 1 Risk Assessment for the central and western areas of site, Chromium III at the location of TP4, Lead and Arsenic at the location of TP7, Lead at the location of TP16 and several speciated PAH analytes (2 no. locations; TP7 and TP13) exceed the target concentrations on this site.

Given the range of the testing data for this part of the site, those areas where elevated PAH, Arsenic, Lead and Chromium III has been recorded have been considered as 'hotspots' of contamination. Therefore, it may be prudent for either the removal, treatment, protection measures and/or further risk assessment (DQRA), of these materials would be required to protect sensitive receptors in the future i.e. residents. At this stage, c.600mm clean cover should be allowed for in all areas of proposed soft landscaping in the western area of site should they be placed in any areas proven to have impacted with PAH contamination.

## EXECUTIVE SUMMARY (Cont'd)

**Contamination (Cont'd)**

From the results of the contamination screening carried out and the Level 1 Risk Assessment for the proposed residential town houses, it can be seen that all of the test results fall within an acceptable range and the recorded chemical concentrations are acceptable for the proposed residential (with homegrown produce) use in this area.

From the results of the leachate screening carried out on selected soil samples, concentrations of potential contaminants do not appear to be sufficiently mobile or sufficiently elevated to pose a significant risk to Controlled Waters or adjacent sites.

## 1.0 Introduction March 2016

As requested by McCarthy & Stone Retirement Lifestyles Limited, and in conjunction with the Phase 1: Desk Top Study Report (DTS) completed for this site (Ref. No. 16-075, dated March 2016), Phase 2: Ground Investigation works have been carried out at land located adjacent to Serpentine Road in Cleckheaton, West Yorkshire, where it is proposed to construct a new CAT II sheltered accommodation, a care home and a series of townhouses including areas of car parking, communal gardens/soft landscaping and private gardens.

The current intrusive investigation has been designed to provide an up to date and robust assessment of the potential ground contamination issues across the site as a whole, for potential risks to Human Health and Controlled Waters, in addition to the potential geotechnical issues associated with the proposed development works, as highlighted within the Phase 1: DTS and previous investigation carried out by Fairhurst (June 2012).

The intrusive investigation works comprised the excavation of 17 no. machine excavated trial pits. All the investigation positions can be seen on the Exploratory Hole Location Plan, a copy of which can be seen in Appendix II. It should be noted that the plan should be used for orientating purposes only, as the location of the positions are approximate and the plan is not to a standard scale. The current trial pits were located in areas designed to provide site wide coverage, target potential problem areas and provide project specific data.

## 2.0 Site Details

**Table 2.1**

| | |
|---|---|
| **Site Name & Address:** | Land adjacent to Serpentine Road, Cleckheaton, West Yorkshire, BD19 3NA. |
| **National Grid Reference:** | 418910, 425540 (representative for the central part of the site). |
| **Description of Location:** | The site was previously occupied by Albion Iron Works and Northgate Mills. The most recent use of the site includes an MOT garage (all of the former structures on site have recently been demolished). The site is located adjacent to Serpentine Road in Cleckheaton, West Yorkshire. |
| **Site Boundaries:** | N = Residential Housing, E = Disused Land, S = Tesco Supermarket and Petrol Filling Station & W = Public Open Space (former railway land). |
| **Site Shape & Development Details:** | The site is irregular in shape, occupying an area of c.1.36 hectares (Ha). Proposals involve the construction of a CAT II sheltered accommodation, a care home and a series of residential town houses, including areas of car parking, soft landscaping and private gardens. |
| **Site Setting:** | The site surfacing comprises areas of mixed hard-standing (i.e. tarmac and concrete) associated with the previous development, as well as areas of vegetation. Demolition rubble was also noted at the surface. |

## 3.0 Scope of Works

The information contained in this report is limited to the area of the site, as indicated on the Existing Site Layout Plan shown in Appendix I, and to those areas accessible during the ground investigation. The depths of strata on the record sheets are recorded from current ground levels. The investigation positions have been located across the site to provide further site wide coverage and when considering the full scope of the development any features and / or issues not specifically mentioned in this report cannot be assumed to have been covered.

**Table 3.1**

| | |
|---|---|
| **Client:** | McCarthy & Stone Retirement Lifestyles Limited. |
| **Project type:** | Proposed retirement and assisted living accommodation, a care home & town houses. |
| **Site Location plan:** | See Appendix I. |
| **Layout plans:** | See Appendix I. |
| **Intrusive Investigation Works:** | 17 no. mechanically excavated trial pits (TP's 01 – 17). |

## 3.0 Scope of Works (Cont'd)

**Table 3.1 (Cont'd)**

| | |
|---|---|
| **Laboratory Testing:** | Geotechnical & Ground Contamination. |
| **CLEA Classification:** | Residential (both with and without homegrown produce). |
| **Reporting:** | Factual & Interpretative. |

### 3.1 Investigation Rationale:-

The locations for the intrusive investigation work have been designed to provide site wide coverage, target potential problem areas and provide project specific data. This ground investigation has been designed to provide information on the issues highlighted in the aforementioned DTS undertaken for the site. The rationale behind the location of each exploratory position is summarised in Table 3.2 below.

**Table 3.2**

| Potential issue | Exploratory Hole |
|---|---|
| Geotechnical ground conditions for foundation design and concrete classification. | TP's 01 to 17 |
| Determine the levels of contamination present within the initial soil deposits with a view to determining the risks posed towards the future site end-users and Controlled Waters. | TP's 01, 02, 04, 06, 07, 12, 13, 14, 15, 16 & 17 |
| Investigate areas of former storage tanks. | TP's 07 & 18 |
| Investigate areas of former electrical sub-stations. | HDTP1 & HDTP2 |

### 3.2 Sampling & Site Protocols:-

All works associated with this ground contamination assessment and investigations have generally been completed in accordance with BS10175: British Standard Code of Practice for the Investigation of Potentially Contaminated Sites (2011) & CLR11, with the following precautions specific to this project.

#### 3.2.1 Contamination Sampling:-

Samples were recovered by a representative of ARC Environmental Ltd. during the intrusive investigation works. All samples were stored at approximately 4°C using cool boxes and ice packs prior to delivery to a UKAS/MCERTS accredited laboratory. Sampling was carried out in accordance with 'Technical Policy Statement 63: UKAS Policy on Deviating Samples'.

#### 3.2.2 Onsite Health & Safety Requirements:-

All site representatives wore relevant and appropriate PPE including (where appropriate) safety footwear, high visibility jacket/vest, hard hat, eye protection and overalls. In addition, disposable latex gloves were used when handling any potentially contaminated materials and when rinsing all sampling tools. Each site vehicle contained a suitable First Aid kit with hand wash station/cleansing products (i.e. sanitary wipes).

#### 3.2.3 Avoiding Cross-Contamination between Sample Locations:-

With regards to the trial pits, the samples were recovered manually using dedicated disposable plastic gloves, replaced between each sample recovery with the equipment being cleaned between each investigation position.

## 4.0 Ground Conditions

For an accurate description of the ground conditions encountered at each investigation position, reference should be made to the trial pit record sheets attached in Appendix II. It should be noted that there is always the possibility of variation in the ground conditions around and between the trial pit locations.

### 4.1 Soil Profile:-

A summary of the soil profile for this site can be seen in Table 4.1 below and on the following page.

**Table 4.1**

| Type of Strata | Depths Recorded | Description & General Comments |
|---|---|---|
| MADE GROUND: | From c.0.00m up to c.0.10m and c. 3.70m | Made ground was encountered in all of the exploratory positions and generally included an initial surfacing of concrete or tarmac with occasional areas of gravelly sand.<br><br>The underlying made ground deposits generally comprised a gravelly sand material which typically included ash, fragments of concrete and bricks. Locally, red shale, slag and metal were recorded.<br><br>Within the ashy gravelly sand material in TP07, a slight hydrocarbon odour was recorded. |
| DRIFT GEOLOGY: | Not recorded | ~ |
| SOLID GEOLOGY: (Lower Coal Measures) | From c. 0.10m up to c. 4.20m | Solid geological deposits were recorded in each exploratory position directly below made ground materials.<br><br>The solid deposits generally comprised an initially completely weathered SILTSTONE, which was recovered as a "firm" sandy clay. The completely weathered material was proven to overlie more competent siltstone deposits at depth.<br><br>Locally, weathered and completely weathered SANDSTONE was proven (TP's 02, 06, 09, 15, 16 and 17).<br><br>In the north western corner of site, a shallow intact COAL was recorded in TP01 (c.1.40m to c.2.00m) and TP03 (c.0.45m to c.1.20m). On inspection, the coal was recovered as a grey to brownish black coarse gravel (inferred Lignite). |

bcgl = Below current ground levels.

The Mining Assessment undertaken as part of the Phase 1: Desk Study highlighted that the site is indicated to lie within a high risk development area and is recorded within an area of probable shallow coal mine workings. A Coal Authority Mining Report for the site concluded that the site is not within the likely zone of influence from past underground workings, however coal may be present at or close to the surface and this may have been worked at some time in the past.

The previous Fairhurst investigation included the drilling of 2 no. rotary boreholes to depths of between c.22m (RBH1) and c.27m (RBH2) at the site. No coal was recorded in RBH1. Intact coal was recorded between c. 10.50m and c.10.80m in RBH2. From this investigation an intact inferred Lignite type coal seam was recorded as shallow depth in TP01 and TP03.

## 4.0 Ground Conditions (Cont'd)

### 4.1 Soil Profile (Cont'd):-

Based on Mining Assessment and intrusive investigations undertaken, it is considered that no further assessment or intrusive investigation works are required with regards to historical coal mining activities and it can be seen there is no significant risk to the site associated with past shallow coal mining activities (i.e. crown hole formation or mine gas).

### 4.2 Groundwater and Trial Pit Wall Stability:-

All of the trial pits remained dry throughout, however as good practice, it would be considered prudent, particular within deeper excavations, to allow for the introduction of temporary groundwater control measures (i.e. sump pumping equipment) and adequate shoring should perched areas of groundwater be encountered, in order to take care of any potential future shallow water ingresses within the underlying deposits, particularly where open excavations are present and are to remain open to the natural elements.

During the trial pit survey, all of the excavations remained stable throughout, however adequate trench support during any future earthworks phase of the development is recommended given the variable nature of materials particularly when exposure to surface water infiltration or groundwater at depth.

## 5.0 Insitu Testing

### 5.1 Insitu Hand Shear Vane Tests:-

Insitu hand vane tests were carried out using an insitu hand vane tester on the completely weathered solid geological deposits encountered across the site which resembled cohesive type deposits. The insitu hand vane tester takes direct readings of shear strength.

The peak vane value is determined by a calibrated scale ring built into the head assembly. The cross handle is used both to push the vane to the desired test depth and apply the shearing torque. The results are summarised in Table 5.2 below and can also be found adjacent to the appropriate sample level, on the graphic trial pit record sheets.

**Table 5.2**

| Type of Strata | Range of Shear Strength Values | Result Details |
|---|---|---|
| SOLID GEOLOGY: (Completely weathered Siltstone) | 44kN/m² - 56kN/m² | Medium strength ("Firm" deposits) |

## 6.0 Laboratory Testing

All geotechnical testing was carried out in accordance with BS1377:1990:Parts 1-9 unless otherwise stated, at a UKAS accredited laboratory. Ground contamination screening was undertaken by a suitably experienced and qualified laboratory (UKAS and MCERTS accredited, unless otherwise stated).

### 6.1 Determination of pH & $SO_4$:-

Representative samples of the made ground and natural solid strata recovered during the investigation, were tested in order to determine their acidic (pH) and soluble sulphate ($SO_4$) levels. The results are shown in Table 6.1 on the following page and are also contained within Chemtech Environmental Limited Analytical Report (Ref no: 58513), a copy of which can be seen in Appendix III.

# 6.0 Laboratory Testing (Cont'd)

## 6.1 Determination of pH & $SO_4$ (Cont'd):-

**Table 6.1**

| Position | Depth (m) | Strata | pH | $SO_4$(mg/l) | Design $SO_4$ Class | ACEC Class |
|---|---|---|---|---|---|---|
| TP1 | 0.50 | MG | 7.5 | 50 | DS-1 | AC-1 |
| TP1 | 1.50 | NS | 5.3 | 94 | DS-1 | AC-3z |
| TP2 | 0.20 | MG | 8.8 | 521 | DS-2 | AC-2 |
| TP4 | 0.20 | MG | 11.6 | 344 | DS-1 | AC-1 |
| TP4 | 2.00 | NS | 4.4 | 373 | DS-1 | AC-4z |
| TP6 | 0.50 | MG | 8.1 | 1126 | DS-2 | AC-2 |
| TP7 | 0.20 | MG | 7.7 | 178 | DS-1 | AC-1 |
| TP7 | 1.50 | MG | 7.8 | 96 | DS-1 | AC-1 |
| TP8 | 0.30 | MG | 10.1 | 735 | DS-1 | AC-1 |
| TP10 | 1.00 | MG | 8.1 | 22 | DS-1 | AC-1 |
| TP11 | 0.20 | MG | 8.3 | 71 | DS-1 | AC-1 |
| TP12 | 0.20 | MG | 8.3 | 44 | DS-1 | AC-1 |
| TP13 | 0.20 | MG | 7.8 | 872 | DS-2 | AC-2 |
| TP13 | 1.0 | NS | 5.8 | 54 | DS-1 | AC-2z |
| TP14 | 0.20 | MG | 8.0 | 2481 | DS-3 | AC-3 |
| TP15 | 0.40 | MG | 10.3 | 289 | DS-1 | AC-1 |
| TP16 | 0.40 | MG | 7.9 | 300 | DS-1 | AC-1 |
| TP17 | 0.40 | NS | 7.6 | 87 | DS-1 | AC-1 |

ACEC = Aggressive Chemical Environment for Concrete Site Classification. MG=Made Ground, NS=Natural Strata.

From these results it can be seen that the pH values for the samples of soil tested range from 4.4 up to 11.6, and the amount of soluble sulphate present ranged between 22 to 2481mg/l. Therefore, in accordance with BRE Special Digest 1: 2005, the site can be given a classification of Class DS-3. When considering the nature of the materials tested and assuming mobile groundwater, the assessment of the Aggressive Chemical Environment for Concrete (ACEC), is AC-4z.

## 6.2 Determination of Liquid & Plastic Limits:-

On visual inspection of the siltstone deposits, these material were recovered as a cohesive type material through the initial completely weathered zone. In such a condition, completely weathered siltstone can often behave like a cohesive soil. Therefore, 3 no. representative samples of the natural siltstone recovered from the site were tested in order to determine their liquid and plastic limit, so that these materials could be classified. The results are summarised in Table 6.2 below and are also contained in the PSL Analytical Report (ref no.: PSL16/0646), a copy of which is contained in Appendix III.

**Table 6.2**

| Position | Depth (m) | M/C (%) | LL | PL | PI | Class | % Passing 425µm Sieve |
|---|---|---|---|---|---|---|---|
| TP1 | 2.50 | 12 | 28 | 20 | 8 | CL | 59 |
| TP8 | 2.00 | 15 | 29 | 21 | 8 | CL | 60 |
| TP14 | 1.50 | 17 | 30 | 21 | 9 | CL | 59 |

M/C = Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, CL = Clay Low, CI = Clay Intermediate, CH = Clay High.

From these results it can be seen that the samples tested are inorganic in nature, and when plotted on the plasticity chart fall within the low plasticity range. From the resulting plasticity indices, these siltstone samples acting as 'clays' display very low volume change (shrinkage or swelling) potential, when taking into account the amount passing the 425µm sieve.

## 6.0 Laboratory Testing (Cont'd)

### 6.2 Determination of Liquid & Plastic Limits (Cont'd):-

Therefore, it can be seen that the siltstone materials are unlikely to undergo significant changes in volume locally, if large changes in their natural moisture content were to occur due to seasonal variations or the like, and if new foundations were to be based within these deposits, they would need to be taken down to a minimum depth of 0.75m below finished ground level.

However, an increase in the minimum foundation depths may be required to reach competent strata or if foundations are within close proximity to existing or proposed trees. Reference should be made to BS5837: 2012, 'Trees in relation to design, demolition & construction', along with the NHBC Standards, 'Building near trees'.

### 6.3 Determination of Calorific Value

A representative sample of the shallow coal encountered at the location of TP01 was tested in order to determine the calorific value, the result of which is used to assess the potential for combustibility. The result can be seen in Table 6.3 below and is also contained in the Chemtech Environmental Analytical Test Report No. 58513, a copy of which can be found in Appendix III.

**Table 6.3**

| Position | Depth (m) | Strata | Calorific Value (kJ/kg) |
|---|---|---|---|
| TP01 | 1.50 | Coal | 7766 |

In summary, the results of the test undertaken on the shallow coal (inferred Lignite "brown" type coal) revealed a calorific value of 7766kJ/kg and as such this material is considered to represent a high risk of combustibility, in accordance with ICRCL 61/84 'Notes on the fire hazards of contaminated land'.

From these results it can be seen that the shallow coal identified is a potentially combustible material.

In accordance with ICRCL 61/84 potentially combustible materials should be overlain by a c.>1m thickness of non-combustible material, in order to isolate these materials from potential ignition at the surface. In addition, due to the nature of the identified shallow coal deposits, all services should be laid within an inert layer of material, to once again, isolate these materials from potential sources of heating/ignition, and thereby negating any potential risk. Due to the shallow depth coal is noted at in TP1 and TP3, foundations should be taken down through the coal where it is first encountered in excavations. A licence from the Coal Authority may be required prior to undertaking such excavation works.

### 6.4 Contamination Screening / Screening Strategy:-

Representative samples of materials encountered were passed onto Chemtech Environmental Ltd of Stanley, Co. Durham so that soil and water contamination screening could be carried out. The results of all the testing can be found in the Chemtech Analytical Report 58513, a copy of which can be found in Appendix III.

Representative samples were screened using a standard generic contamination suite (based on the current CLEA SGV listed analytes with historical additions) which is used to assess typical made ground (disturbed natural strata mixed with anthropogenic debris) of an unknown source. Taking into account the findings of the DTS as well as the known site history, speciated PAH, speciated TPH, BTEX, PCB's and asbestos testing was also undertaken.

The contamination results have been used to carryout Level 1 Quantitative Human Health Risk Assessment for the ground contamination present and are discussed in Section 7.0. The total analysis carried out is summarised on the following page:

## 6.0 Laboratory Testing (Cont'd)

### 6.4 Contamination Screening / Screening Strategy (Cont'd):-

Soil:-

- 12 no. soil samples screened for a generic (metals and non organics) soil suite which includes the following determinands; Arsenic, Cadmium, Chromium (III & VI), Copper, Lead, Mercury, Nickel, Selenium, Zinc, Cyanide, pH, and Total Organic Carbon (TOC).
- 12 no. soil samples screened for Speciated Polycyclic Aromatic Hydrocarbons (PAH's) – based on the current USEPA 16 PAH's + Benzo(j)fluoranthene.
- 12 no. soil samples screened for Speciated Total Petroleum Hydrocarbons (TPH's - full Ali & Aro EC split).
- 12 no. soil samples screened for Benzene, Toluene, Ethylbenzene, m, p & o-Xylene (BTEX) and MTBE.
- 12 no. soil samples screened for asbestos containing materials (ACM's).
- 2 no. soil samples screened for PCB's (ICES 7 Congeners).

Leachate:-

- 4 no. samples screened for Generic Suite – based on the Generic Soils Suite above (suite comprises; Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, pH, Sulphate, Sulphide, and free Cyanide).
- 4 no. samples screened for Speciated PAH, Speciated TPH and BTEX.

Following completion of the contamination screening undertaken on various samples from this site, Level 1 Quantitative Human Health and Controlled Waters Risk Assessments for the ground contamination present have been undertaken, generally in accordance with CLR11: Model Procedures for the Management of Land Contamination. These results can also be used for a preliminary assessment for off-site disposal classification. A detailed description of the Assessment Framework and Methodology used by ARC for these risk assessments can be found in Appendix IV.

## 7.0 Level 1 Ground Contamination Risk Assessment

### 7.1 Methodology:-

This quantitative ground contamination risk assessment uses the current UK practice for assessing the risks from land contamination, which is based on the established *source-pathway-receptor* pollutant linkage methodology and 'suitable for use' approach (Part IIA, EPA 1990 - inserted through Section 57 EA 1995).

Based on the Conceptual Site Model (CSM) for this site (described further in the following Section 7.2), a site specific screening strategy has been developed (see Section 6.6) and the risks from potential contaminants have been assessed for both Human Health and Controlled Waters. The results of the risk assessments can be found in Sections 7.4, 7.5, 7.6 (Human Health) and 7.7 (Controlled Waters). Comments regarding off-site disposal can also be found in Appendix V.

# 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

## 7.2 Conceptual Site Model (CSM):-

Following the results of the intrusive investigation works, a Conceptual Site Model (CSM) has been developed for this site. In addition, Table 7.1 below summarises the various contaminant sources, plausible migration pathways and potentially sensitive receptors identified for this site, assuming no remediation, additional protection measures and/or removal of the sources of contamination takes place.

**Table 7.1**

| | ***Sources (S)*** |
|---|---|
| **S1** | Made ground below the site associated with previous site history (i.e. demolition of the former buildings on site). Potential for Asbestos Containing Materials (ACMS).<br><br>**No asbestos fibres detected.** |
| **S2** | Potential contamination associated with the historical land use (i.e. Albion Iron Works and Northgate Mills with associated tanks, chimneys and structures).<br><br>**Elevated Chromium III in the location of TP4. Slightly elevated PAHs (TP07 & 13), Elevated Arsenic (TP07) and Lead (TP16).** |
| **S3** | Potential PCB contamination from former electrical substation central onsite and to the immediate north west.<br><br>**Testing results for PCB's were recorded below laboratory detection limits.** |
| **S4** | Potential localised hotspots of contamination associated with possible spillages from tanks on site.<br><br>**Elevated PAH's recorded in the location of TP07.** |
| **S5** | Potential hydrocarbon contamination associated with fuel tanks from the former Cleckheaton Motor Co., which was located in the south eastern area of the site and offsite Petrol Filling Station to the south west.<br><br>**No elevated contaminants recorded in the location of TP14.** |
| **S6** | Potential contamination associated with the historical land adjacent use (i.e. railway land to the west, timber yard to the north east and print works to the south east).<br><br>**No visual or olfactory evidence of contamination.** |

| | ***Pathways (P)*** |
|---|---|
| **P1** | Ingestion |
| **P2** | Inhalation of indoor / outdoor air |
| **P3** | Dermal contact |
| **P4** | Migration through grounded and existing services |
| **P5** | Surface run off and leachate migration |
| **P6** | Direct contact with building materials |

| | ***Receptors (R)*** |
|---|---|
| **R1** | Human health (End users and construction workers) |
| **R2** | Groundwater within the Secondary A Aquifer<br><br>**Leachate testing results all fall within acceptable limits.** |
| **R3** | Building materials* |
| **R4** | Adjacent sites |
| **R5** | Flora and fauna* |

* = Not included in the Human Health & Controlled Waters Risk Assessment.

## 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

### 7.2 Revised Conceptual Site Model (CSM) (Cont'd):-

7.2.1 Sources:-

The site is covered by a layer of made ground (ground level up to c.3.70m in thickness) which represents a source of ground contamination for this site as highlighted in the previous site investigation. Apart from the location of TP7, there was no visual or olfactory evidence of any contamination such as fuels (associated with former UST etc.). In TP7, a slight hydrocarbon odour was noted within the made ground deposits, and this is considered to be associated with historical tanks at this location of the site. The previous investigation undertaken by Fairhurst in 2012 also recorded elevated PAH's in BH1; which was positioned in the same location of TP7.

Additionally there was no visual evidence of asbestos/asbestos containing materials or the like within the made ground deposits.

However, ash was encountered within the made ground deposits across the site. Locally, red shale and slag was also recorded within the made ground. Such materials potentially contain higher levels of organic contaminants such as PAH's/TPH's and are additionally potentially aggressive to building materials and sub-surface concrete.

Therefore, representative samples of the shallow soils (made ground) encountered have been assessed using an appropriate screening suites.

The made ground materials were observed as generally 'inert' type material with a probable low ground gas generation potential. Based on the nature of the made ground onsite, the site is not considered to be at risk from potentially significant ground gases such as methane and carbon dioxide.

7.2.2 Pathways:-

When considering the proposed end use (both retirement/assisted living and commercial), and without considering treatment, removal or protection measures, there are some potential plausible pathways available for direct contact, dermal contact, ingestion, inhalation, wind (dust / particulate), volatilization, and vertical and lateral transportation below the site.

Within the CLEA Risk Assessment Model for Human Health, there are 3 exposure mediums considered for on site receptors, comprising ingestion of soil containing contaminants, inhalation of contaminated dust/vapours and dermal contact, with up to 10 no. exposure pathways considered, as show below.

- *1. Ingestion of soil and indoor dust 2. Consumption of homegrown produce and attached soil 3. Dermal contact (indoor) 4. Dermal contact (outdoor) 5. Inhalation of dust (indoor) 6. Inhalation of dust (outdoor) 7. Inhalation of vapour (indoor) 8. Inhalation of vapour (outdoor) 9. Oral background intake 10. Inhalation background intake.*

Where the future site has hard cover and below new structures, a number of these pathways may not be available. In addition, when considering the potential pathways for leachate migration, where either hard cover and/or future surface water drainage systems are present, the potential effects of surface infiltration or contaminated surface water runoff will be greatly reduced.

Similarly, when considering the construction work force, exposure pathways through direct contact, ingestion and dust inhalation will be available during part of the construction process, and therefore adequate PPE should be provided to protect the work force during this period.

## 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

### 7.2 Revised Conceptual Site Model (CSM) (Cont'd):-

7.2.3 Receptors:-

Within the CLEA Risk Assessment Model for Human Health, the potential receptors are assessed initially on site end use, followed by a delineation of age category (i.e. child or adult), with default settings for *Residential, Allotment* and *Public Open Space (Park)* end uses based on a child aged 0 to 6 years, *Public Open Space (Residential)* based on a child aged 3 to 9 and *Commercial* end uses based upon a working exposure period of up to 49 years (i.e. 16 to 65).

Key generic assumptions for *Residential* and *Public Open Space (Residential)* are based upon a typical residential property, consisting of a two-storey small terraced house, with private garden, and a *Commercial* end use based upon a typical commercial or light industrial property, consisting of a three-storey office building (pre-1970). No buildings are anticipated for *Allotment* or *Public Open Space (Park)* end uses.

Within the CLEA Risk Assessment Model for Human Health there are 6 no. generic end use categories presently in use, as follows;

*1) Residential - with home grown produce, 2) Residential - without home grown produce, 3) Allotments, 4) Commercial 5) Public Open Space – Residential, 6) Public Open Space - Park*

Therefore, given the various development proposals for the site, for the Level 1 Risk Assessment, the best fit end use categories for this site have been taken as:

*1) Residential - with home grown produce (private town houses)*

*&*

*2) Residential - without home grown produce (care home, retirement and assisted living accommodation)*

For Controlled Waters and assuming a worst case scenario, the primary receptor for the Level 1 Risk Assessment is the solid Lower Coal Measures strata (Secondary A Aquifer).

### 7.3 Screening Strategy:-

From the results of the intrusive works, representative samples of materials across the site have been chosen for screening, using a generic soil suite, to reflect the more homogeneous nature of the potential contaminants within the general matrix of the made ground encountered.

There was no visual, olfactory or analytical evidence of significant heavy or gross contamination, such as waste oils, fuels, etc. or the like found across the site other than a slight hydrocarbon odour recorded in TP7. However, when considering the historic uses of the site, representative samples have also been screened for speciated PAH, speciated TPH, BTEX, Asbestos and PCB's.

### 7.4 Level 1 Human Health Risk Assessment (Soils) (Retirement & Assisted Living):-

7.4.1 Generic Contaminants:-

The results of the analysis and risk assessment have been summarised in Table 7.2 on the following page. The generic soil screening results can be found in Appendix III.

# 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

## 7.4 Level 1 Human Health Risk Assessment (Soils) (Retirement & Assisted Living) (Cont'd):-

7.4.1 Generic Contaminants (Cont'd):-

**Table 7.2**

| Analyte | Critical Conc. ($C_C$) mg/kg | No. of Samples Screened | Max. Conc. ($C_M$) recorded | Statistical Upper Confidence Limit | Has $UCL_{0.95}$ exceeded $C_C$ | No. of Samples > $C_C$ | Is $C_M$ a statistical outlier |
|---|---|---|---|---|---|---|---|
| **Arsenic** | **40(1)** | **10** | **47** | **25.749** | **NO** | **1** | **NO** |
| Cadmium | 85(1) | 10 | 0.9 | 0.630 | NO | 0 | NO |
| **Chromium III** | **910(1)** | **10** | **3418** | **1857.352** | **YES** | **1** | **YES** |
| Chromium IV | 6(1) | 10 | <1 | 0.5 | NO | 0 | NO |
| Copper | 7100(1) | 10 | 166 | 108.495 | NO | 0 | NO |
| **Lead** | **310(2)** | **10** | **1146** | **668.456** | **YES** | **2** | **NO** |
| Mercury | 56(1) | 10 | <0.5 | 0.25 | NO | 0 | NO |
| Nickel | 180(1) | 10 | 55 | 38.658 | NO | 0 | NO |
| Selenium | 430(1) | 10 | 1.7 | 1.212 | NO | 0 | NO |
| Zinc | 40000 | 10 | 257 | 179.279 | NO | 0 | NO |
| Cyanide | 34(3) | 10 | <1 | 0.5 | NO | 0 | NO |

(1) = LQM CIEH Suitable 4 Use Levels, 6% SOM (S4UL Nov 2014) – *Residential without homegrown produce*, (2) = C4SL Values, 6% SOM (*Residential without homegrown produce*), (3) = ATRISK$^{SOIL}$ SSV, **Bold** = result exceeds critical concentration, Note = All units are mg/kg.

The results of the analysis and risk assessment have identified the following:

- The maximum concentration ($C_M$) value of Arsenic (TP7, 1.50m), Lead (TP7, 0.20m and TP16, 0.40m) and Chromium (TP4, 0.20m) were raised above the critical concentration ($C_C$) value. Statistical analysis suggest that the recorded Arsenic. Lead concentrations are potentially pervasive across the site. However on further examination of the elevated concentrations, these all relate to the location of TP7 (with the exception of 1 no. elevated lead concentration in the position of TP16) and Chromium III (TP4). Therefore it can concluded that the elevated analytes above are more realistically localised 'hotspots' of contamination rather than potentially pervasive.
- Consequently, based on the contamination screening results obtained for the various soil deposits tested there may be a requirement for removal, treatment, protection measures and/or further risk assessment in order to protect the proposed site end-users.

7.4.2 Organic Contaminants – Speciated PAH's, TPH's & BTEX:-

The results of the analysis and risk assessment have been summarised in Table 7.3 below and on the following page. The organic soil screening results can be found in Appendix III.

**Table 7.3**

| Analyte (targeted screening) | Critical Conc. ($C_C$) mg/kg | No. of Samples Screened | Max. Conc. ($C_M$) recorded | Statistical Upper Confidence Limit | Has $UCL_{0.95}$ exceeded $C_C$ | No. of Samples > $C_C$ | Is $C_M$ a statistical outlier |
|---|---|---|---|---|---|---|---|
| **Speciated PAH's** | | | | | | | |
| Acenaphthene | 6000(1) | 10 | 5.87 | 3.220 | NO | 0 | NO |
| Acenaphthylene | 6000(1) | 10 | 0.64 | 0.351 | NO | 0 | YES |
| Anthracene | 3700(1) | 10 | 25.28 | 13.781 | NO | 0 | NO |
| **Benzo(a)anthracene** | **14(1)** | **10** | **62.83** | **34.279** | **YES** | **1** | **NO** |
| **Benzo(a)pyrene** | **3.2(1)** | **10** | **58.23** | **32.076** | **YES** | **3** | **NO** |
| **Benzo(b)fluoranthene** | **4(1)** | **10** | **64.48** | **35.539** | **YES** | **3** | **NO** |

(1) = LQM CIEH Suitable 4 Use Levels (S4UL Nov 2014) – *Residential without plant uptake* 6% SOM). **Bold** = result exceeds critical concentration, Note = All units are mg/kg.

# 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

## 7.4 Level 1 Human Health Risk Assessment (Soils) (Retirement & Assisted Living) (Cont'd):-

7.4.2 Organic Contaminants – Speciated PAH's, TPH's & BTEX (Cont'd):-

**Table 7.3 (Cont'd)**

| Analyte (targeted screening) | Critical Conc. ($C_C$) mg/kg | No. of Samples Screened | Max. Conc. ($C_M$) recorded | Statistical Upper Confidence Limit | Has $UCL_{0.95}$ exceeded $C_C$ | No. of Samples > $C_C$ | Is $C_M$ a statistical outlier |
|---|---|---|---|---|---|---|---|
| **Speciated PAH's** | | | | | | | |
| Benzo(ghi)perylene | 360(1) | 10 | 29.43 | 16.395 | NO | 0 | NO |
| Benzo(k)fluoranthene | 110(1) | 10 | 28.90 | 15.867 | NO | 0 | NO |
| **Chrysene** | **31(1)** | **10** | **50.94** | **27.845** | **NO** | **1** | **NO** |
| **Dibenz(ah)anthracene** | **0.32(1)** | **10** | **9.06** | **4.997** | **YES** | **3** | **NO** |
| Fluoranthene | 1600(1) | 10 | 163.24 | 88.598 | NO | 0 | NO |
| Fluorene | 3800(1) | 10 | 4.74 | 2.599 | NO | 0 | NO |
| Indeno(123cd)pyrene | 46(1) | 10 | 40.11 | 22.197 | NO | 0 | NO |
| Naphthalene | 5.6(1) | 10 | 0.39 | 0.283 | NO | 0 | NO |
| Phenanthrene | 1500(1) | 10 | 67.66 | 37.038 | NO | 0 | NO |
| Pyrene | 3800(1) | 10 | 139.54 | 75.788 | NO | 0 | NO |
| **Speciated TPH's** | | | | | | | |
| TPH Aliphatic (EC5-EC6) | 160(1) | 10 | <0.1 | 0.05 | NO | 0 | NO |
| TPH Aliphatic (EC6-EC8) | 530(1) | 10 | <0.1 | 0.05 | NO | 0 | NO |
| TPH Aliphatic (EC8-EC10) | 150(1) | 10 | <0.1 | 0.05 | NO | 0 | NO |
| TPH Aliphatic (EC10-EC12) | 770(1) | 10 | 7 | 6.964 | NO | 0 | NO |
| TPH Aliphatic (EC12-EC16) | 4400(1) | 10 | 104 | 64.248 | NO | 0 | NO |
| TPH Aliphatic (EC16-EC35) | 110000(1) | 10 | 4052 | 2283.692 | NO | 0 | NO |
| TPH Aliphatic (EC35-EC44) | 110000(1) | 10 | 454 | 260.549 | NO | 0 | NO |
| TPH Aromatic (EC5-EC7) | 1400(1) | 10 | <0.01 | 0.005 | NO | 0 | NO |
| TPH Aromatic (EC7-EC8) | 3900(1) | 10 | <0.01 | 0.005 | NO | 0 | NO |
| TPH Aromatic (EC8-EC10) | 270(1) | 10 | 0.02 | 0.013 | NO | 0 | NO |
| TPH Aromatic (EC10-EC12) | 1200(1) | 10 | <1 | 0.5 | NO | 0 | NO |
| TPH Aromatic (EC12-EC16) | 2500(1) | 10 | 10 | 5.798 | NO | 0 | NO |
| TPH Aromatic (EC16-EC21) | 1900(1) | 10 | 406 | 221.251 | NO | 0 | NO |
| TPH Aromatic (EC21-EC35) | 1900(1) | 10 | 322 | 177.317 | NO | 0 | NO |
| TPH Aromatic (EC35-EC44) | 1900(1) | 10 | 34 | 19.308 | NO | 0 | NO |
| **BTEX** | | | | | | | |
| Benzene | 0.7(1) | 10 | <0.01 | 0.005 | NO | 0 | NO |
| Toluene | 1900(1) | 10 | <0.01 | 0.005 | NO | 0 | NO |
| Ethylbenzene | 190(1) | 10 | <0.01 | 0.005 | NO | 0 | NO |
| Xylene | 180(1) | 10 | 0.02 | 0.005 | NO | 0 | NO |

(1) = LQM CIEH Suitable 4 Use Levels (S4UL Nov 2014) – *Residential without plant uptake* 6% SOM). **Bold** = result exceeds critical concentration, Note = All units are mg/kg.

The results have identified the following:

- The maximum concentration ($C_M$) value of Benzo(a)anthracene (TP7, 0.20m), Benzo(a)pyrene (TP7, 0.20m and 1.50m), Benzo(b)fluoranthene (TP7, 0.20m, 1.50m and TP13, 0.20m), Chrysene (TP7, 0.20m) and Dibenz(ah)anthracene (TP7, 0.20m, 1.50m and TP13, 0.20m) were raised above the critical concentration ($C_C$) value. Whilst statistical analysis suggest that the above elevated PAH's are potentially pervasive across the site, these are associated with only 2 no. exploratory positions (TP7 and TP13) are more realistically localised 'hotspots' of contamination rather than potentially pervasive.
- Statistical analysis suggest that level of Acenaphthylene is an outliers. However, since the $C_M$ values do not exceeds the $C_C$ value for this site, it is felt that this analyte do not represent a potential risk.
- Consequently, based on the contamination screening results obtained for the various soil deposits tested there may be a requirement for removal, treatment, protection measures and/or further risk assessment in order to protect the proposed site end-users.

# 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

## 7.4 Level 1 Human Health Risk Assessment (Soils) (Retirement & Assisted Living) (Cont'd):-

7.4.3 Other Soil Contaminants – PCB's:-

Due to the presence of the former electrical sub-station positioned to the east of the site, and a former sub-station immediately beyond the site to the north west, 2 no. samples were subject to a suite of PCB (PCB Congener's) analysis. The PCB screening results can be found in Appendix III.

The testing results all fall below laboratory detection limits. Based on the PCB testing results, the potential risks to human health are considered negligible.

## 7.5 Level 1 Human Health Risk Assessment (Soils) (Town Houses):-

7.5.1 Generic Contaminants:-

In the eastern area of the site, a series of residential town houses are proposed. Therefore the results of the testing from TP12 and TP14 were compared to a series of Generic Assessment Criteria values based on a 'residential with homegrown produce' end-use.

The results of the analysis and risk assessment have identified the following:

**Table 7.4**

| Analyte | Critical Conc. ($C_C$) mg/kg | No. of Samples Screened | Max. Conc. ($C_M$) recorded | No. of Samples > $C_C$ |
|---|---|---|---|---|
| Arsenic | 37(1) | 2 | 19 | 0 |
| Cadmium | 11(1) | 2 | 0.3 | 0 |
| Chromium III | 910(1) | 2 | 60 | 0 |
| Chromium IV | 6(1) | 2 | <1 | 0 |
| Copper | 2400(1) | 2 | 166 | 0 |
| Lead | 200(2) | 2 | 124 | 0 |
| Mercury | 40(1) | 2 | 2.1 | 0 |
| Nickel | 180(1) | 2 | 36 | 0 |
| Selenium | 250(1) | 2 | 1.7 | 0 |
| Zinc | 3700 | 2 | 175 | 0 |
| Cyanide | 34(3) | 2 | <1 | 0 |

(1) = LQM CIEH Suitable 4 Use Levels (S4UL Nov 2014) – *Residential with homegrown produce*, (2) = C4SL Values (*Residential with homegrown produce*), (3) = ATRISK$^{SOIL}$ SSV, NAD = No Asbestos Detected. Note = All units are mg/kg.

- None of the $C_M$ values for the analytes screened exceed the chosen $C_C$ values for this site.

7.5.2 Organic Contaminants – Speciated PAH's, TPH's & BTEX:-

**Table 7.5**

| Analyte (targeted screening) | Critical Conc. ($C_C$) mg/kg | No. of Samples Screened | Max. Conc. ($C_M$) recorded | No. of Samples > $C_C$ |
|---|---|---|---|---|
| **Speciated PAH's** | | | | |
| Acenaphthene | 1100(1) | 2 | 0.02 | 0 |
| Acenaphthylene | 920(1) | 2 | <0.01 | 0 |
| Anthracene | 11000(1) | 2 | 0.05 | 0 |
| Benzo(a)anthracene | 13(1) | 2 | 0.08 | 0 |

(1) = LQM CIEH Suitable 4 Use Levels (S4UL Nov 2014) – *Residential with homegrown produce*, (2) = C4SL Values (*Residential with homegrown produce*), (3) = ATRISK$^{SOIL}$ SSV, NAD = No Asbestos Detected. Note = All units are mg/kg.

# 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

## 7.5 Level 1 Human Health Risk Assessment (Soils) (Town Houses) (Cont'd):-

7.5.2 Organic Contaminants – Speciated PAH's, TPH's & BTEX:-

**Table 7.5 (Cont'd)**

| Analyte (targeted screening) | Critical Conc. ($C_C$) mg/kg | No. of Samples Screened | Max. Conc. ($C_M$) recorded | No. of Samples > $C_C$ |
|---|---|---|---|---|
| **Speciated PAH's** | | | | |
| Benzo(a)pyrene | 3(1) | 2 | 0.11 | 0 |
| Benzo(b)fluoranthene | 3.7(1) | 2 | 0.14 | 0 |
| Benzo(ghi)perylene | 350(1) | 2 | 0.08 | 0 |
| Benzo(k)fluoranthene | 100(1) | 2 | 0.06 | 0 |
| Chrysene | 27(1) | 2 | 0.10 | 0 |
| Dibenz(ah)anthracene | 0.3(1) | 2 | 0.02 | 0 |
| Fluoranthene | 890(1) | 2 | 0.15 | 0 |
| Fluorene | 860(1) | 2 | 0.02 | 0 |
| Indeno(123cd)pyrene | 41 (1) | 2 | 0.08 | 0 |
| Naphthalene | 13(1) | 2 | 0.09 | 0 |
| Phenanthrene | 440(1) | 2 | 0.16 | 0 |
| Pyrene | 2000(1) | 2 | 0.15 | 0 |
| **Speciated TPH's** | | | | |
| TPH Aliphatic (EC5-EC6) | 160(1) | 2 | <0.1 | 0 |
| TPH Aliphatic (EC6-EC8) | 530(1) | 2 | <0.1 | 0 |
| TPH Aliphatic (EC8-EC10) | 150(1) | 2 | <0.1 | 0 |
| TPH Aliphatic (EC10-EC12) | 760(1) | 2 | 2 | 0 |
| TPH Aliphatic (EC12-EC16) | 4300(1) | 2 | 7 | 0 |
| TPH Aliphatic (EC16-EC35) | 110000(1) | 2 | 334 | 0 |
| TPH Aliphatic (EC35-EC44) | 110000(1) | 2 | 129 | 0 |
| TPH Aromatic (EC5-EC7) | 300(1) | 2 | <0.01 | 0 |
| TPH Aromatic (EC7-EC8) | 660(1) | 2 | <0.01 | 0 |
| TPH Aromatic (EC8-EC10) | 190(1) | 2 | <0.01 | 0 |
| TPH Aromatic (EC10-EC12) | 380(1) | 2 | <1 | 0 |
| TPH Aromatic (EC12-EC16) | 660(1) | 2 | <1 | 0 |
| TPH Aromatic (EC16-EC21) | 930(1) | 2 | 3 | 0 |
| TPH Aromatic (EC21-EC35) | 1700(1) | 2 | 3 | 0 |
| TPH Aromatic (EC35-EC44) | 1700(1) | 2 | 1 | 0 |
| **BTEX** | | | | |
| Benzene | 0.37(1) | 2 | <0.01 | 0 |
| Toluene | 660(1) | 2 | <0.01 | 0 |
| Ethylbenzene | 260(1) | 2 | <0.01 | 0 |
| Xylene | 310(1) | 2 | <0.01 | 0 |

(1) = LQM CIEH Suitable 4 Use Levels (S4UL Nov 2014) – *Residential with homegrown produce*, (2) = C4SL Values (*Residential with homegrown produce*), (3) = ATRISK$^{SOIL}$ SSV, NAD = No Asbestos Detected. Note = All units are mg/kg.

The results of this Level 1 risk assessment have identified the following:

- None of the $C_M$ values for the Speciated PAH, TPH, and BTEX analytes screened exceed the chosen residential with homegrown produce $C_C$ values for the eastern area of the site.

## 7.6 Level 1 Human Health Risk Assessment (Soils) (Asbestos):-

The results of the asbestos screening are summarised in Table 7.6 on the following page.

# 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

## 7.6 Level 1 Human Health Risk Assessment (Soils) (Asbestos) (Cont'd):-

**Table 7.6**

| Position | Depth (m) | Chrysotile (white) | Amosite (brown) | Crocidolite (blue) | Anthophyl-lite | Actinolite | Tremolite |
|---|---|---|---|---|---|---|---|
| TP01 | 0.50 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP02 | 0.20 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP04 | 0.20 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP06 | 0.50 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP07 | 0.20 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP07 | 1.50 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP12 | 0.20 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP13 | 0.20 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP14 | 0.20 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP15 | 0.40 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP16 | 0.40 | NAD | NAD | NAD | NAD | NAD | NAD |
| TP17 | 0.40 | NAD | NAD | NAD | NAD | NAD | NAD |

NAD = No Asbestos detected, Y = Yes asbestos present, NAD = No asbestos present.

The results have identified the following:

- As can be seen from the samples screened, the results have not identified the presence of any asbestos fibres.
- Consequently, there is no requirement for removal, treatment, protection measures and/or further risk assessment in order to protect the existing end users (i.e. no risk to human health) from potential Asbestos fibres.

## 7.7 Level 1 Controlled Waters Risk Assessment (Groundwater):-

Based on the results of the soils screening carried out on the various samples chosen, leachate screening has been carried out on a total of 4 no. soil samples and the results have been used to complete a Level 1 Risk Assessment for the potential impact on controlled waters and adjacent sites (based on EA Remedial Targets Methodology: Hydrological Risk Assessment for Land Contamination, 2006).

The results have been assessed against appropriate EQS Standards and are summarised in Table 7.7 below and on the following page:

**Table 7.7**

| Analyte | Target Conc. ($T_C$) µg/l | No. of Samples Screened | Max. Conc. ($C_M$) recorded | Has $C_M$ exceeded $C_C$ | No. of Samples > $C_C$ |
|---|---|---|---|---|---|
| Arsenic | 50(1) | 4 | 5.57 | NO | 0 |
| Boron | 1000(2) | 4 | 32 | NO | 0 |
| Cadmium | 5(2) | 4 | <0.07 | NO | 0 |
| Chromium | 50(2) | 4 | 42.6 | NO | 0 |
| Copper | 2000(2) | 4 | 6.4 | NO | 0 |
| Lead | 25(2) | 4 | 5.3 | NO | 0 |
| Mercury | 1(2) | 4 | 0.030 | NO | 0 |
| Nickel | 20(2) | 4 | 8.3 | NO | 0 |
| Selenium | 10(2) | 4 | 0.57 | NO | 0 |
| Zinc | 5000(2) | 4 | 25 | NO | 0 |
| Sulphate | 250mg/l(1) | 4 | 41 | NO | 0 |
| Cyanide | 50(2) | 4 | <20 | NO | 0 |

(1) = EQS UK freshwater, (2) = EQS Drinking water, (3) = Detection Limit. **Bold** = result exceeds critical concentration

## 7.0 Level 1 Ground Contamination Risk Assessment (Cont'd)

### 7.7 Level 1 Controlled Waters Risk Assessment (Groundwater) (Cont'd):-

**Table 7.7 (Cont'd)**

| Analyte | Target Conc. ($T_C$) µg/l | No. of Samples Screened | Max. Conc. ($C_M$) recorded | Has $C_M$ exceeded $C_C$ | No. of Samples > $C_C$ |
|---|---|---|---|---|---|
| Acenaphthene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Acenaphthylene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Anthracene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Benzo(a)anthracene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Benzo(a)pyrene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Benzo(b)fluoranthene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Benzo(ghi)perylene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Benzo(k)fluoranthene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Chrysene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Dibenz(ah)anthracene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Fluoranthene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Fluorene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Indeno(123cd)pyrene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Naphthalene | 10(1) | 4 | <0.1 | NO | 0 |
| Phenanthrene | 0.1(2) | 4 | <0.1 | NO | 0 |
| Pyrene | 0.1(2) | 4 | <0.1 | NO | 0 |
| TPH Aromatic EC5-EC7 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC7-EC8 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC8-EC10 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC10-EC12 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC12-EC16 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC16-EC21 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC21-EC35 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aromatic EC35-EC44 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC5-EC6 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC6-EC8 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC8-EC10 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC10-EC12 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC12-EC16 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC16-EC21 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC16-EC35 | 10 (1) | 4 | <1 | NO | 0 |
| TPH Aliphatic EC35-EC44 | 10 (1) | 4 | <1 | NO | 0 |
| Benzene | 30(1) | 4 | <1 | NO | 0 |
| Toluene | 30(1) | 4 | <1 | NO | 0 |
| Ethylbenzene | 300(3) | 4 | <1 | NO | 0 |
| Xylene | 30(1) | 4 | <1 | NO | 0 |

(1) = EQS UK freshwater, (2) = EQS Drinking water, (3) = Detection Limit. **Bold** = result exceeds critical concentration

The results have identified the following:

- The Target Concentration ($C_T$) values for all the contaminants screened do not exceed the $C_c$ values taken for this site.
- From these results and the risk assessment completed, it can be seen that the made ground deposits present on site do not represent a risk to any Controlled Waters or adjacent sites, and therefore there is no requirement for further risk assessment (DQRA) and/or remedial measures to be implemented.

## 8.0 Conclusions & Recommendations

### 8.1 Ground Conditions:-

Information from the previous Fairhurst investigation (June 2012) proved made ground across the site to depths up to c.2.50m. Fairhusts recorded the made ground generally as a sand material which frequently contained bricks and ash. From the 17 no. mechanically excavated trial pits undertaken by Arc Environmental Limited, similar ground conditions were recorded and included tarmac/concrete or gravel surfacing overlying a generally ashy sand material. The made ground typically contained bricks, fragments of concrete, and occasional red shale and slag locally. A slight hydrocarbon odour was recorded in the location of TP07.

BGS information considered within the Phase 1: Desk Top Study (DTS) revealed that the site lies in an area where superficial drift deposits (such as clay, sand and gravel etc.) is either thin or absent. The intrusive investigation revealed that no superficial drift deposits were present at the site.

The DTS identified the underlying solid geology as the Lower Coal Measures which comprises alternating bands of sandstones, mudstone and occasional coal. From the intrusive works undertaken, the made ground deposits directly overlie natural sandstone and siltstone deposits. Locally, the solid deposits were completely weathered and recovered as a 'clay' type material. The trial pits extended through the completely/highly weathered zone and into more competent solid materials at depth.

In the north western area of the site, shallow intact 'brown' (Lignite) type coal was encountered at depths of between c.1.40m to c.2.00m (TP01) and c.0.45m and c.1.20m (TP03).

From the findings of the Coal Mining Risk Assessment undertaken as part of the DTS, it has been established that the site lies within a high risk development area. The Coal Authority Mining Report for the site concluded that coal may be present at or close to the surface and this may have been worked at some time in the past. The previous Fairhurst investigation included the sinking of 2 no. rotary boreholes to depths of between c.22m and c.27m. These deeper rotary boreholes revealed solid drilling throughout with no recorded indicators of coal workings (such as broken ground, voids etc). It is therefore concluded that there is no significant risk to the site associated with past shallow coal mining activities.

### 8.2 Groundwater:-

During the investigation works completed, no ingresses/strikes were noted.

Notwithstanding the above, as good practice, shallow water ingresses and potential instability issues should be anticipated for this proposed development particularly during construction related excavations (i.e. foundations, drainage, etc.). Therefore, when construction related excavations are undertaken, it would be prudent to allow for the introduction of temporary groundwater control measures (i.e. sump pumping equipment, adequate shoring), in order to take care of any localised ingresses of water during the construction period, and especially during the wetter periods of the year.

### 8.3 Foundation Options:-

It can be seen that a number of geotechnical issues have been identified on site, which will influence the type, design depth and construction of foundations for new structures, for example:-

- Variable thickness, strengths and composition of made ground

## 8.0 Conclusions & Recommendations (Cont'd)

### 8.3 Foundation Options (Cont'd):-

- Variable depth to competent underlying drift deposits
- Variable depth to the solid sandstone and siltstone stratum.
- Presence of shallow intact coal deposits.

When considering the above issues, it is felt that the foundation options given below should prove suitable for the proposed development.

Based on the recorded ground conditions, shallow foundation options may be viable for the proposed structures, such as tradition strip footings/deep strip and trench fill provided that the safe bearing capacities are not exceeded. During the creation of deep excavations there may be instability issues when excavations are left open. As such trench support may be required during the construction of excavations.

During the construction phase, it may also be beneficial for a suitably qualified Geotechnical Engineer / Engineering Geologist to attend site and confirm the correct founding strata has been achieved within all foundation excavations, as variations in the type and nature of the upper ground conditions have been noted.

8.3.1 Proposed Cat II Sheltered Accommodation (North Western Structure):-

It should be noted that shallow intact coal was recorded in the north western area of site. Coal is a combustible material and is generally weak and compressible in nature. As such, we would recommend that foundations are based at least 1.00m above the coal. Based on the depth to the coal (c. 0.45m, TP3), placement of 1.00m of non combustible material is not considered practical.

Therefore foundations should be taken through the full extent of made ground and shallow coal. A licence from the Coal Authority may be require prior to undertaken any excavations into/through the shallow coal deposits. Where strip footing and pad foundations are placed at depth within the completely weathered siltstone, an Allowable Bearing Capacity of 110kN/$m^2$ is achievable. The completely weathered siltstone was recorded at depths of between c.0.80m and c.2.00m.

Alternatively, should structural loadings exceed 110kN/$m^2$, a combination of deep strip and foundation based purely within the more competent siltstone would provide an Allowable Bearing Capacity of 250kN/$m^2$. The more competent siltstone was recorded from depths of c.1.30m (TP05) and c.2.50m (TP01 and TP03).

8.3.2 Proposed Care Home (Central Structure):-

Based on the recorded ground conditions within the central area of the site, the made ground deposits and completely weathered sandstone and siltstone deposits are not considered suitable foundations medium considering the likely structural loadings of the proposed building.

More competent sandstone and siltstone was proven at depths of between c.1.00m (TP9) and c.2.40m (TP11). Therefore deep strip footings and pad foundations placed through the full extent of made ground and completely weathered solid deposits and onto the more competent sandstone and siltstone solid deposits at depth would be suitable. However locally deeper made ground should be anticipated as recorded at the location of TP8 (the latter is outwith the footprint of the proposed structure).

## 8.0 Conclusions & Recommendations (Cont'd)

### 8.3 Foundation Options (Cont'd):-

Given foundations are likely to straddle between both the sandstone and siltstone deposits locally, foundations should be suitably reinforced to avoid differential settlement. An Allowable Bearing Capacity of 250kN/$m^2$ is achievable where foundations are placed purely within the deeper sandstone and siltstone deposits.

8.3.3 Proposed Town Houses (Eastern Structures):-

Considering the recorded ground conditions in the easternmost area of the south, traditional shallow and deep strip footing foundations placed through the made ground deposits and purely within the completely weathered siltstone will give an Allowable Bearing Capacity of 105kN/$m^2$. The completely weathered siltstone was proven at this location at depths of between c.0.70m (TP13) and c.1.60m (TP14).

Should the structural loadings exceed 105kN/$m^2$, a combination of deep strip footings and trench fill foundations should be considered where foundation are taken down through the full extent of made ground and the completely weathered siltstone and placed onto the more competent siltstone which was recorded from depths of between c.1.80m and c.2.90m. Where foundations are based within the competent siltstone at depth, an Allowable Bearing Capacity of 250kN/$m^2$ is achievable.

In accordance with BRE Special Digest 1: 2005, the site can be given a classification of Class DS-3. When considering the nature of the materials tested and assuming mobile groundwater, the assessment of the Aggressive Chemical Environment for Concrete (ACEC), is AC-4z.

### 8.4 Ground Contamination:-

8.5.1 Human Health:-

Given the site proposals, two separate Level 1 Risk Assessments have been considered. In general, the central and western areas of the site will be developed with a care home and retirement and assisted living accommodation with associated car parking and soft landscaping. For this area of the site a 'Residential without homegrown produce' end-use was adopted for the risk assessment. For the eastern area of the site, a 'Residential with homegrown produce' end-use was adopted for the risk assessment given this area of the site will be developed with town houses.

Care Home, Retirement and Assisted Living (West and Centre of Site)

From the results of the contamination screening carried out and the Level 1 Risk Assessment (Section 7.4), it can be seen that Chromium III at the location of TP4, Lead and Arsenic at the location of TP7, Lead at the location of TP16 and several speciated PAH analytes (2 no. locations; TP7 and TP13) exceed the target concentrations on this site.

Given the range of the testing data for this part of the site, those areas where elevated PAH, Arsenic, Lead and Chromium III has been recorded have been considered as 'hotspots' of contamination. Therefore, it may be prudent for either the removal, treatment, protection measures and/or further risk assessment (DQRA), of these materials would be required to protect sensitive receptors in the future i.e. residents. At this stage, c.600mm clean cover should be allowed for in all areas of proposed soft landscaping in the central and western area of site.

## 8.0 Conclusions & Recommendations (Cont'd)

### 8.4 Ground Contamination (Cont'd):-

Town Houses Development (East of Site)

From the results of the contamination screening carried out and the Level 1 Risk Assessment (Section 7.5), it can be seen that all of the test results fall within an acceptable range and the recorded chemical concentrations are acceptable for the proposed residential (with homegrown produce) use in this area.

8.5.2 Controlled Water / Adjacent Sites:-

From the results of the leachate screening carried out on selected soil samples, concentrations of potential contaminants do not appear to be sufficiently mobile or sufficiently elevated to pose a significant risk to Controlled Waters or adjacent sites.

### 8.5 General Comments:-

For any future site works, adequate lateral trench support will be required for excavations, in order to prevent trench wall collapse or over excavations, as well as to create a safe working environment below a depth of 1.20m, and any excavations on this site should remain open for as short a period as possible, since some of these materials may be susceptible to deterioration, if left open to the natural elements for any significant period of time.

Relic structures including a foundation and unknown underground features may be present below the site and therefore it is recommended that a watching brief is undertaken during the construction.

It is also recommended for any future redevelopment works, adequate surface drainage should be designed and installed by a competent contractor, in order to prevent surface water 'ponding' or collection, during and post construction, particularly where the existing surface drainage system is disrupted or damaged.

For deeper excavations, drainage, service runs or the like that may pass close to or beneath any existing or proposed foundations, these should also be undertaken with care and completed prior to the preparation of any new foundations, so as not to allow any loose or granular material to move or 'flow', thus causing settlement to occur to any new foundations based at a higher level. Furthermore, trench support is likely to be required due to unstable drift materials within open excavation walls.

The site lies in an area where <1% of homes are above the action level, in accordance with the BGS, National Geoscience Information Service and their assessment suggests that the site does not require radon protection measures for new dwellings.

This corresponds with the BRE Digest, BR211 (2015) Radon: Guidance on protective measures for new buildings, the site is situated within a clear grid square (1km), and therefore no radon protective measures are required for the site. Furthermore, the site is not at risk from historic coal mining activities.

An "observational technique" can be applied to future design and construction works on this site, and where ground conditions seem to vary from that indicated from the conceptual ground model derived from works to date, then advice from a suitably qualified Engineering Geologist/Geotechnical Engineer should be sought.

**END OF REPORT**

# GENERAL REFERENCES

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  CLR 4: Sampling strategies for contaminated land. Report by The Centre for Research into the Built Environment, The Nottingham Trent University. DoE, 1994.
  CLR 5: Information systems for land contamination. Report by Meta Generics Ltd. DoE, 1994.
  CLR 6: Prioritisation & categorisation procedure for sites which may be contaminated. Report by M J Carter Associates. DoE, 1995.
  CLR11: Model Procedures for the Management of Land Contamination. DEFRA/EA, 2004.
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- BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution (BS 1377-9:1990 is partially superseded by BS EN 1997-2: 2007)
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- BS10175:2011 + A1:2013: Investigation of potentially contaminated sites – Code of practice
- Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D66, 2008 (NHBC, EA, CIEH)
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- Assessing Risks Posed by Hazardous Ground Gases to Buildings, CIRIA C665, 2007
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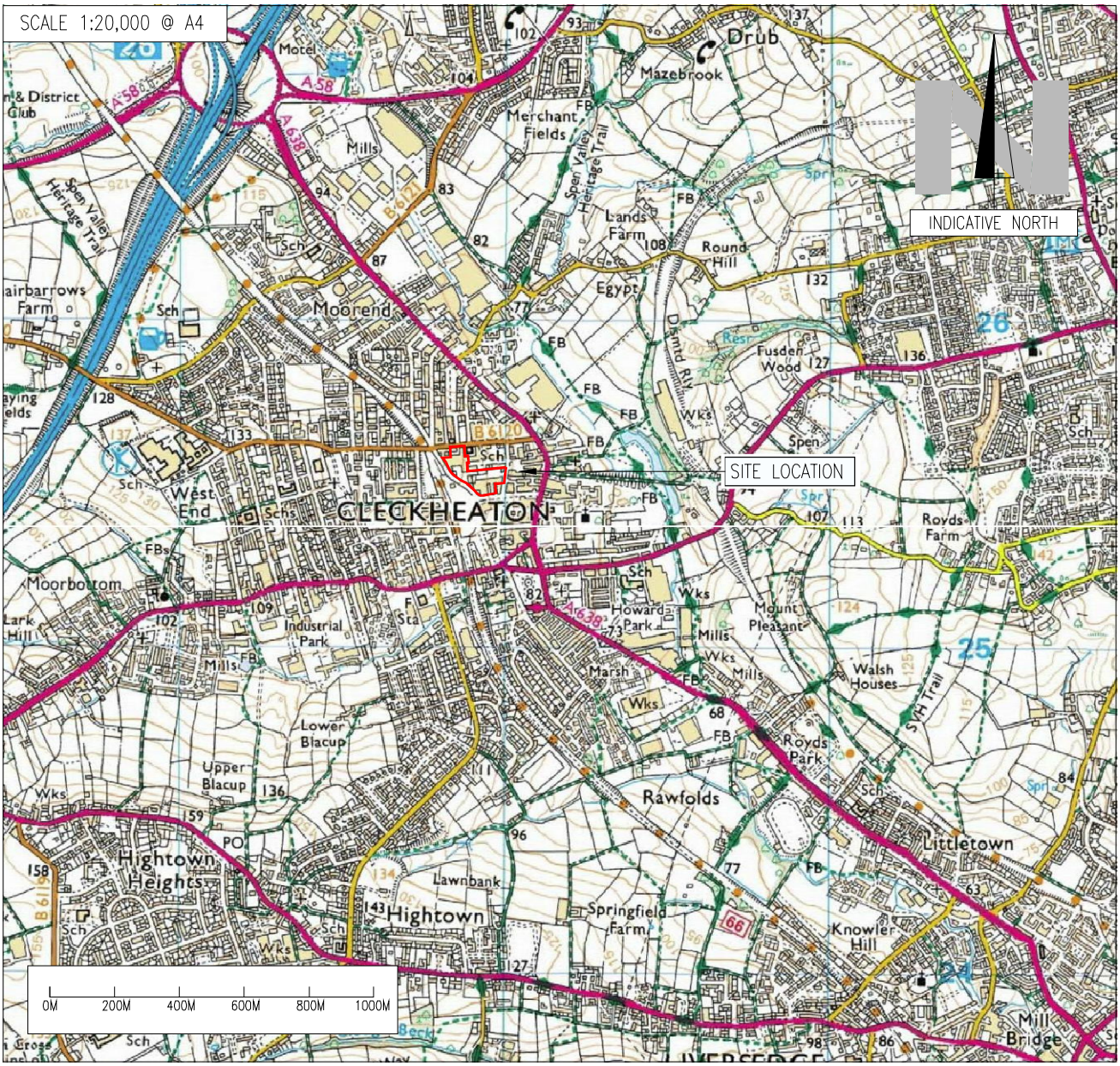
- BS8485: 2015: Code of Practise for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gasses for New Buildings.
- BS8576:2013: Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds
- Category 4 Screening Levels (C4SL's) – DEFRA/CL:AIRE
- Suitable 4 Use Levels (S4UL Nov 2014) – LQM CIEH
- Fairhurst Investigation (Ref: D/I/L/72596/04, June 2012).

# APPENDIX I

**Site Location Plan**
**Aerial Photograph**
**Existing & Proposed Site Layout Plans**

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| rev. | date | amendments | drawn | chckd |
|---|---|---|---|---|
| | | | | |

| Job Reference: | Drawing Number: | Revision: |
|---|---|---|
| 16-075 | – | – |

| Drawn by: | Date: | Scale at A4: |
|---|---|---|
| P.D | 11.02.16 | As Shown |

| Checked by: | Approved by: | |
|---|---|---|
| S.T | S.T | The contractor shall check all dimensions on site before commencement of any works. No dimensions to be scaled off this drawing. |
| | |  |

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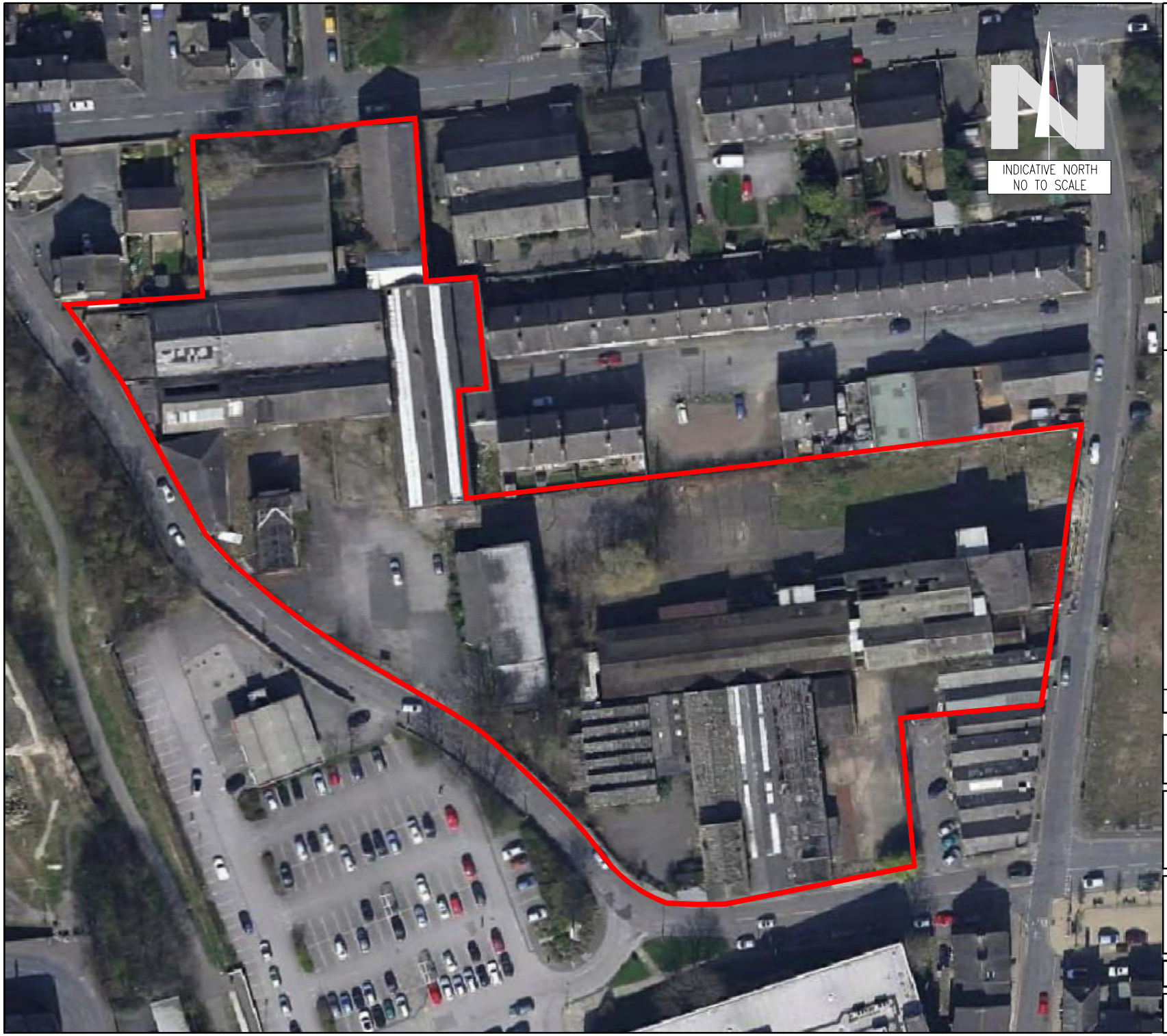
web: www.arc-environmental.com

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web: www.arc-environmental.com



| LEGEND | |
|---|---|
| | APPROXIMATE SITE BOUNDARY |

| rev. | date | amendments | drawn | chckd |
|---|---|---|---|---|

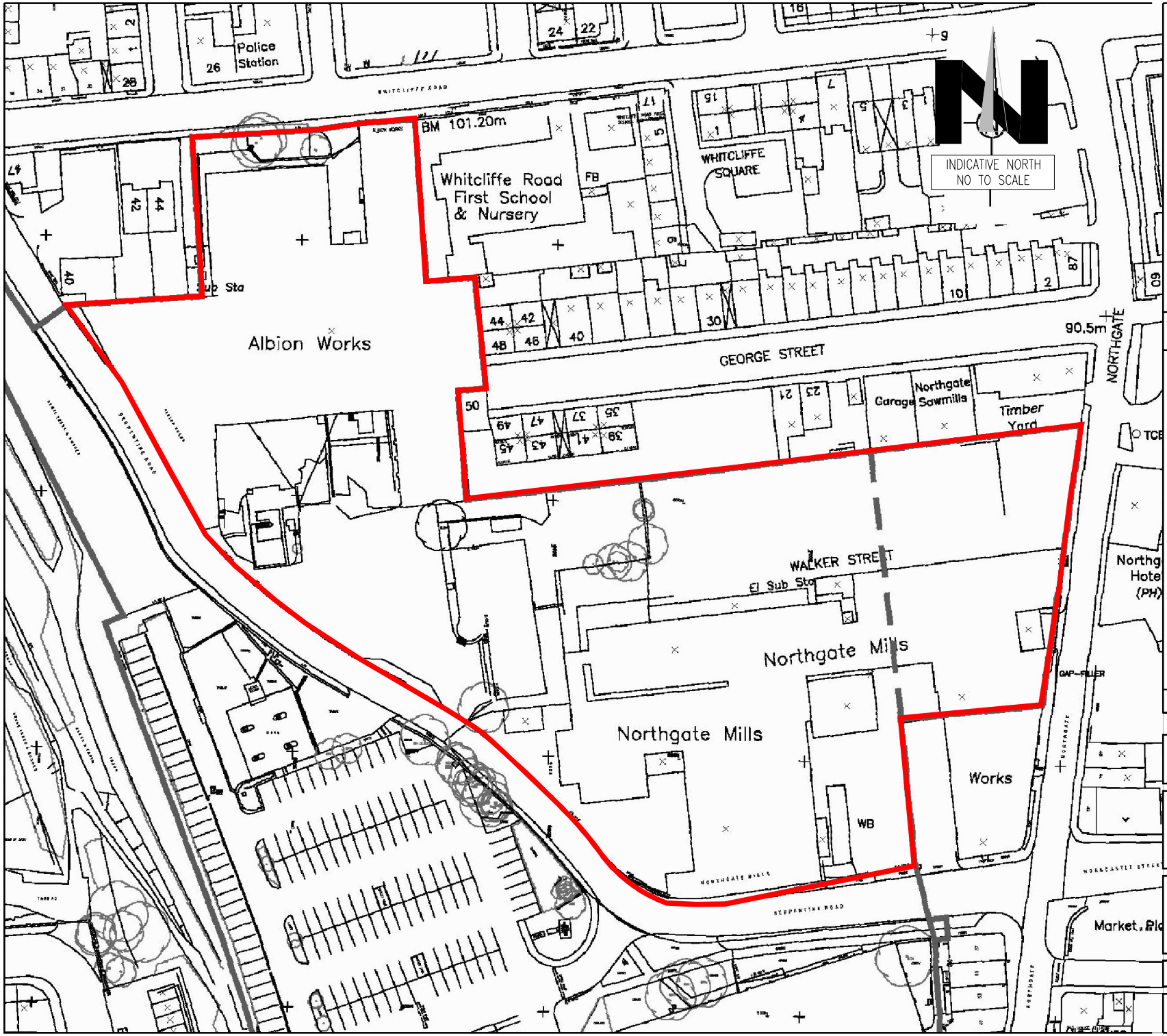
Client: **McCARTHY & STONE RETIREMENT LIFESTYLES LTD**

**Project Title:**
Albion Works and Northgate Mills
Serpentine Road
Cleckheaton, BD19 3NA

**Drawing Title:**
Aerial Photograph

| Scale at A3: | Date: | Drawn by: | Approved by: |
|---|---|---|---|
| NTS @ A3 | 22.02.16 | P.D | S.T |

| Job Ref: | Drg no: | Rev: |
|---|---|---|
| 16-075 | – | – |

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web: www.arc-environmental.com



LEGEND

| | |
|---|---|
| | APPROXIMATE SITE BOUNDARY |

| rev. | date | amendments | drawn | chckd |
|---|---|---|---|---|

Client: **McCARTHY & STONE RETIREMENT LIFESTYLES LTD**

Project Title:
Albion Works and Northgate Mills
Serpentine Road
Cleckheaton, BD19 3NA

Drawing Title:
Existing Site Layout Plan

| Scale at A3: | Date: | Drawn by: | Approved by: |
|---|---|---|---|
| NTS @ A3 | 22.02.16 | P.D | S.T |

| Job Ref: | Drg no: | Rev: |
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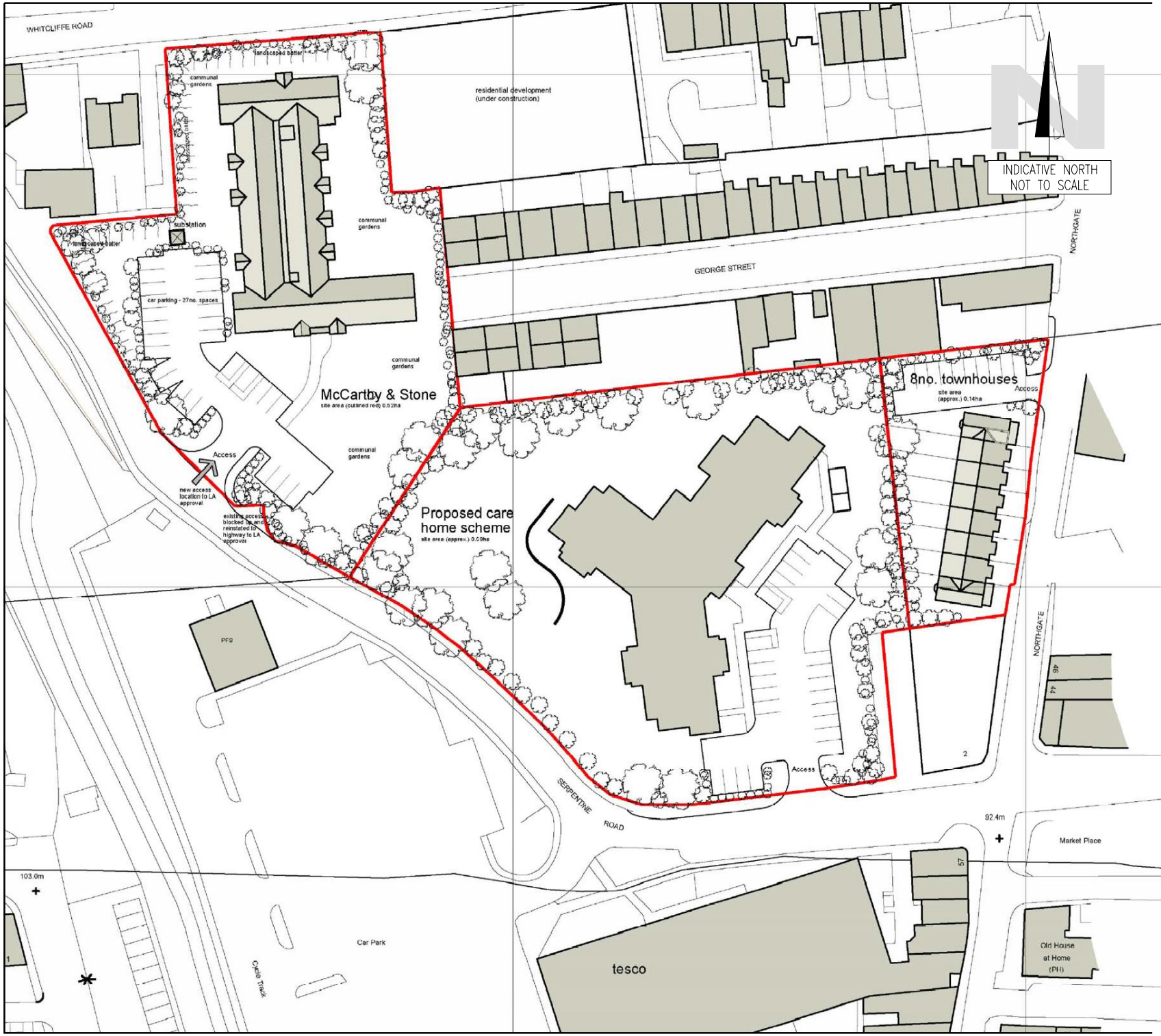
| 16-075 | – | – |





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| LEGEND | |
|---|---|
| | APPROXIMATE SITE BOUNDARY |

| rev. | date | amendments | drawn | chckd |
|---|---|---|---|---|

Client: **McCARTHY & STONE RETIREMENT LIFESTYLES LTD**

**Project Title:**
Albion Works and Northgate Mills
Serpentine Road
Cleckheaton, BD19 3NA

**Drawing Title:**
Proposed Development Layout Plan

| Scale at A3: | Date: | Drawn by: | Approved by: |
|---|---|---|---|
| NTS @ A3 | 22.02.16 | P.D | S.T |

| Job Ref: | Drg no: | Rev: |
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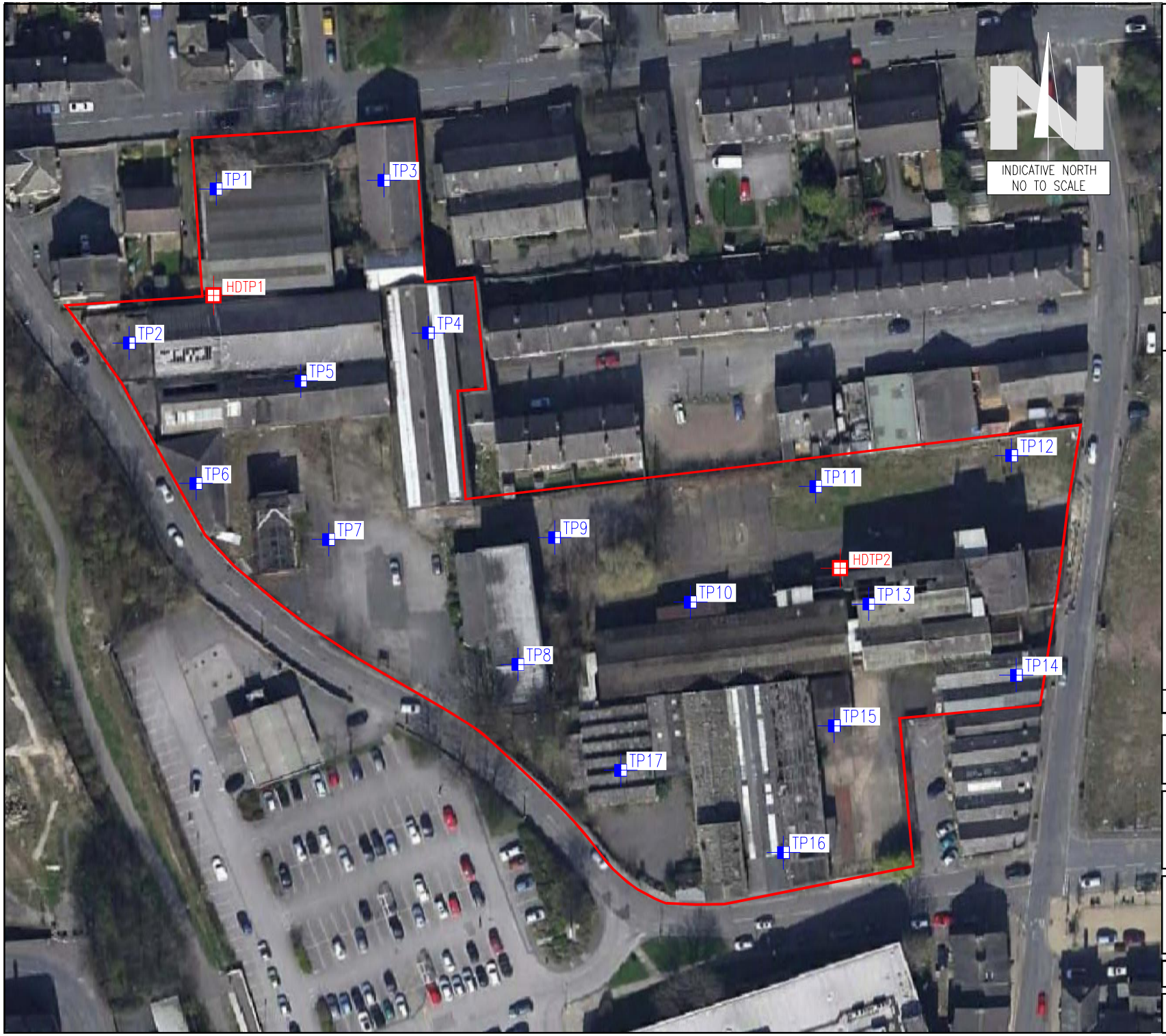
# APPENDIX II

**Exploratory Hole Location Plan,**
**Trial Pit Record Sheets**

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| LEGEND | |
|---|---|
| | MECHANICALLY EXCAVATED TRIAL PIT POSITIONS |
| | MANUALLY EXCAVATED TRIAL PIT POSITION TO EXPOSE EXISTING FOUNDATIONS |

| rev. | date | amendments | drawn | chckd |
|---|---|---|---|---|

Client: **McCARTHY & STONE RETIREMENT LIFESTYLES LTD**

**Project Title:**
Albion Works and Northgate Mills
Serpentine Road
Cleckheaton, BD19 3NA

**Drawing Title:**
Exploratory Hole Location Plan (Existing)

| Scale at A3: | Date: | Drawn by: | Approved by: |
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| Job Ref: | Drg no: | Rev: |
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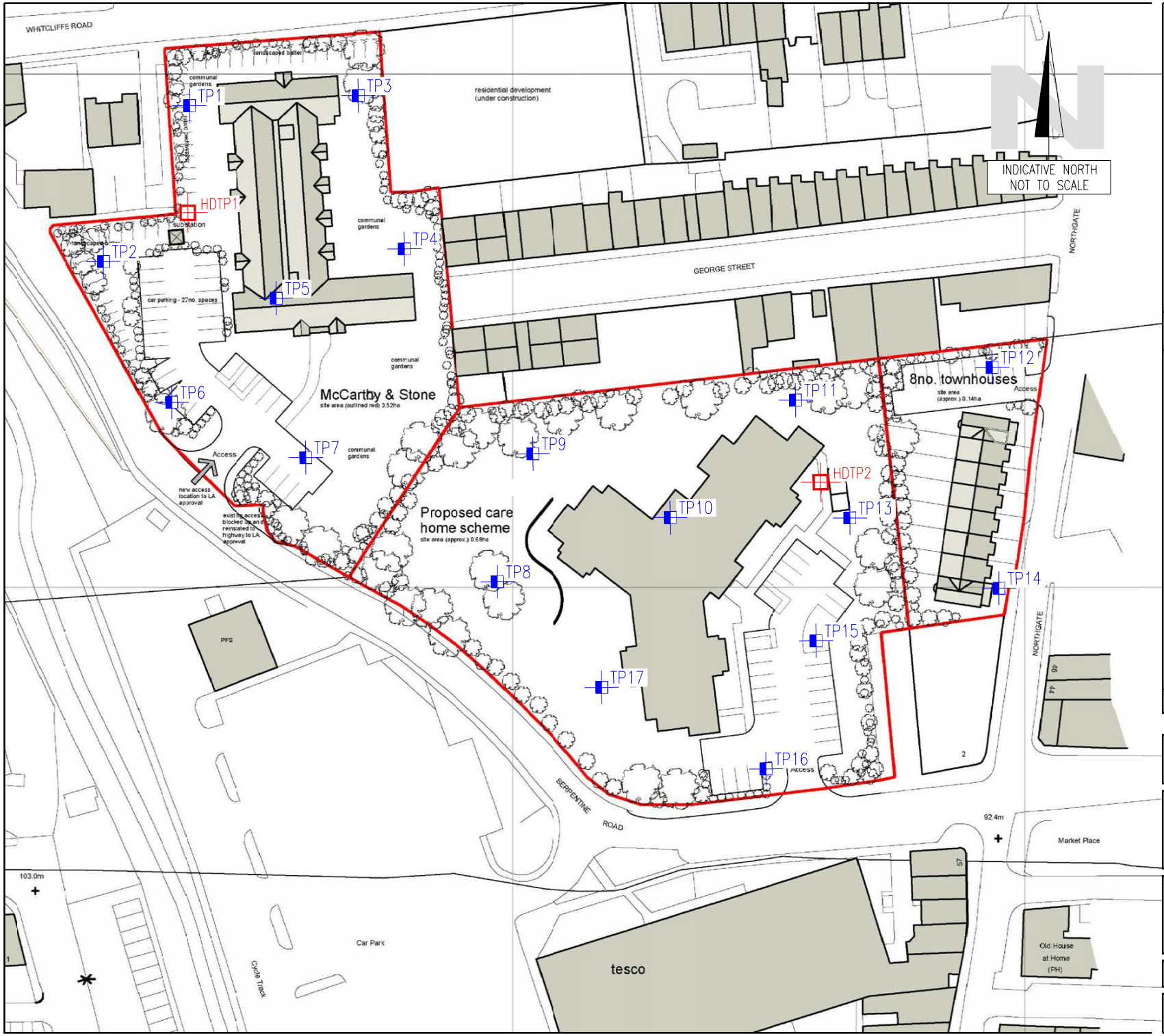



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| LEGEND | |
|---|---|
| | MECHANICALLY EXCAVATED TRIAL PIT POSITIONS |
| | MANUALLY EXCAVATED TRIAL PIT POSITION TO EXPOSE EXISTING FOUNDATIONS |

| rev. | date | amendments | drawn | chckd |
|---|---|---|---|---|

Client: **McCARTHY & STONE RETIREMENT LIFESTYLES LTD**

**Project Title:**
Albion Works and Northgate Mills
Serpentine Road
Cleckheaton, BD19 3NA

**Drawing Title:**
Exploratory Hole Location Plan (Proposed)

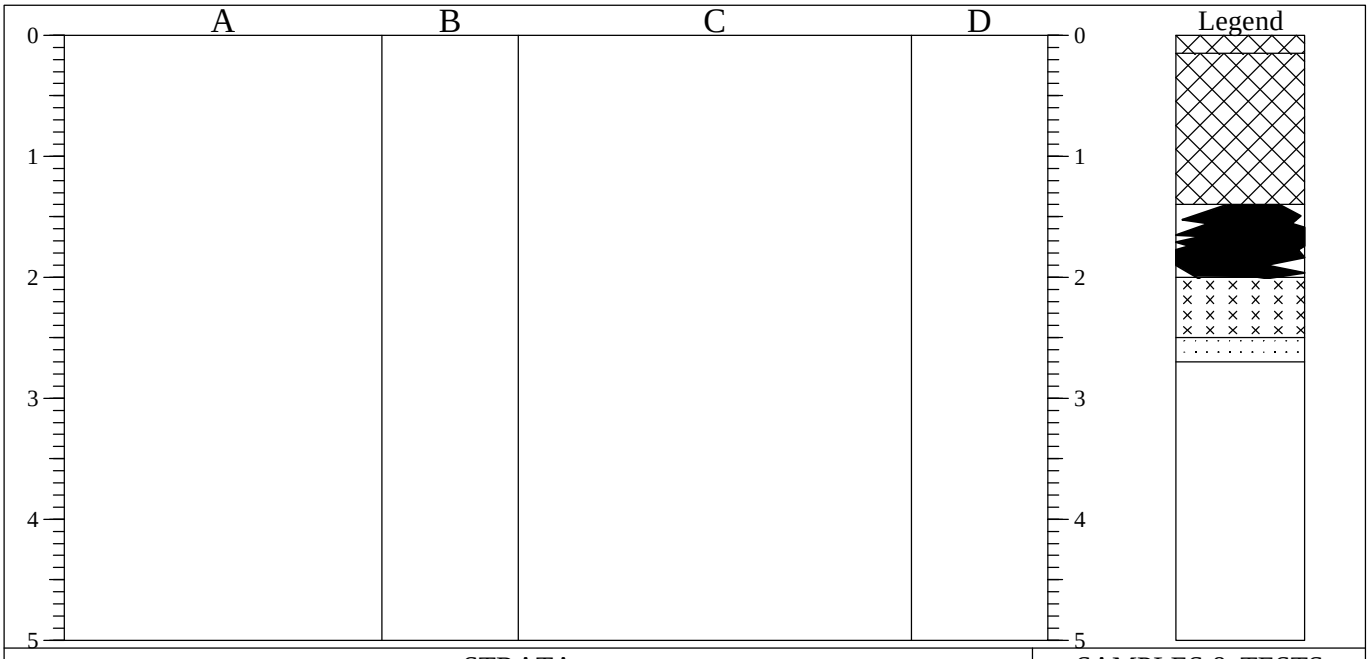
| Scale at A3: | Date: | Drawn by: | Approved by: |
|---|---|---|---|
| NTS @ A3 | 22.02.16 | P.D | S.T |

| Job Ref: | Drg no: | Rev: |
|---|---|---|
| 16-075 | – | – |

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

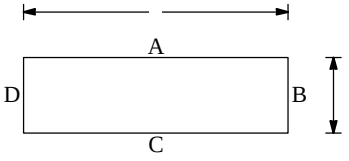
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP01** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| 16-075 | 01-02-16 | | | |
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.15 | | Reinforced concrete with 20mm rebar (MADE GROUND). | | | |
| 0.15-1.40 | | Firm grey brown sandy clay (MADE GROUND). | 0.50 | J/D | |
| 1.40-2.00 | | Grey to brownish black COAL. Recovered as coarse tabular gravels with occasional cobbles of coal (LOWER COAL MEASURES). | 1.50 | D | |
| 2.00-2.50 | | Light brown grey completely weathered SILTSTONE. Siltstone recovered as a firm sandy silt (LOWER COAL MEASURES). | | | |
| 2.50-2.70 | | Light brown fine weathered SANDSTONE (LOWER COAL MEASURES). | 2.50 | D | |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

| All dimensions in metres<br>Scale 1:62.5 | Client<br>McCarthy & Stone<br>Retirement Lifestyles | Method/<br>Plant Used<br>JCB 3CX | Logged By<br>SDT |
|---|---|---|---|

AGS3 UK TP 16-075 LOGS.GPJ AGS3_ALL.GDT 5/4/16

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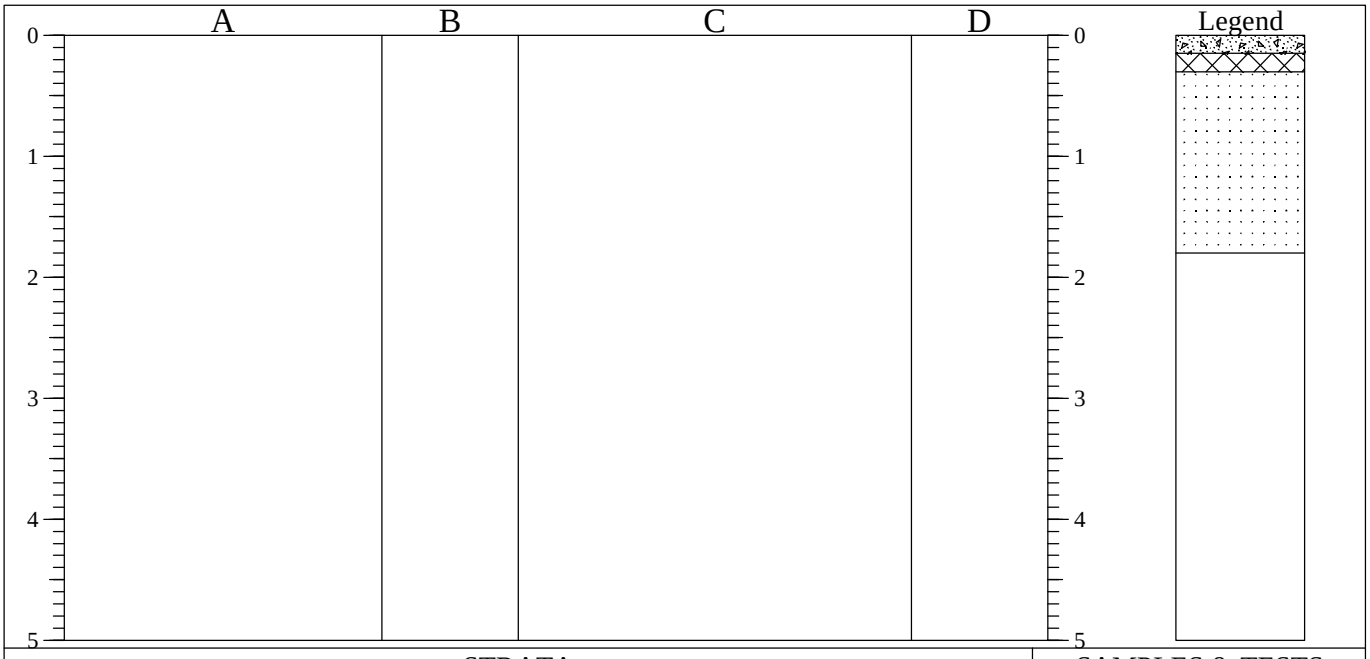
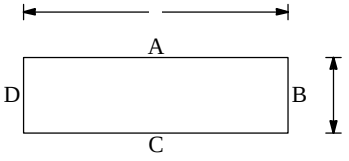
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP02** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| 16-075 | 01-02-16 | | | |
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.15 | | Reinforced CONCRETE (MADE GROUND). | | | |
| 0.15-0.30 | | Brown black very ashy sand with concrete and bricks (MADE GROUND). | 0.20 | J/D | |
| 0.30-1.80 | | Light brown fine weathered SANDSTONE (LOWER COAL MEASURES). | 0.50 | D | |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

| All dimensions in metres<br>Scale 1:62.5 | Client<br>McCarthy & Stone<br>Retirement Lifestyles | Method/<br>Plant Used<br>JCB 3CX | Logged By<br>MR |
|---|---|---|---|

AGS3 UK TP 16-075 LOGS.GPJ AGS3_ALL.GDT 5/4/16

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# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP03** |
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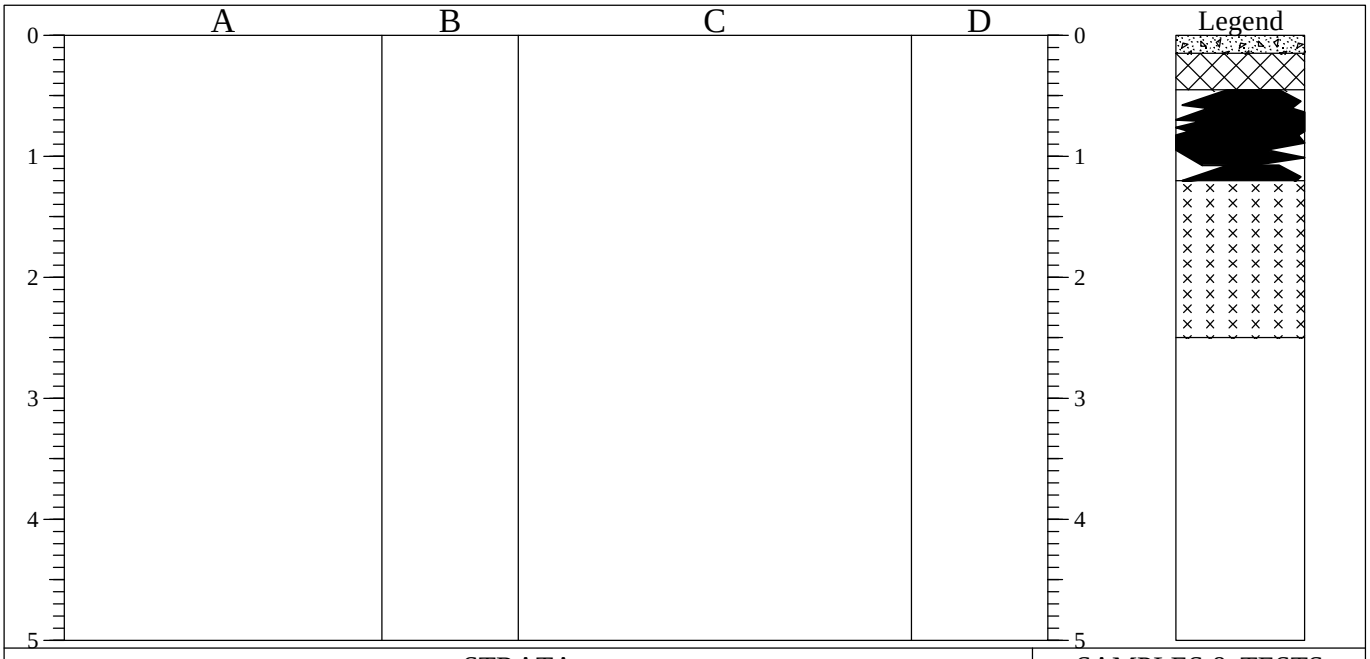
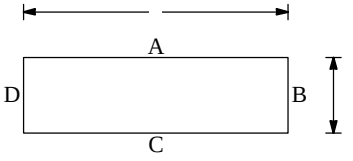
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.15 | | Reinforced concrete with 20mm rebar (MADE GROUND). | | | |
| 0.15-0.45 | | Firm grey brown sandy clay (MADE GROUND). | 0.30 | J/D | |
| 0.45-1.20 | | Grey to brownish black COAL. Recovered as coarse tabular gravels with occasional cobbles of coal (LOWER COAL MEASURES). | 1.00 | D | |
| 1.20-2.50 | | Light brown grey completely weathered SILTSTONE. Siltstone recovered as a firm sandy silt (LOWER COAL MEASURES). | 1.50 | V | 56 kPa |
| 2.50 | | Light brown grey weathered SILTSTONE (LOWER COAL MEASURES). | | | |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

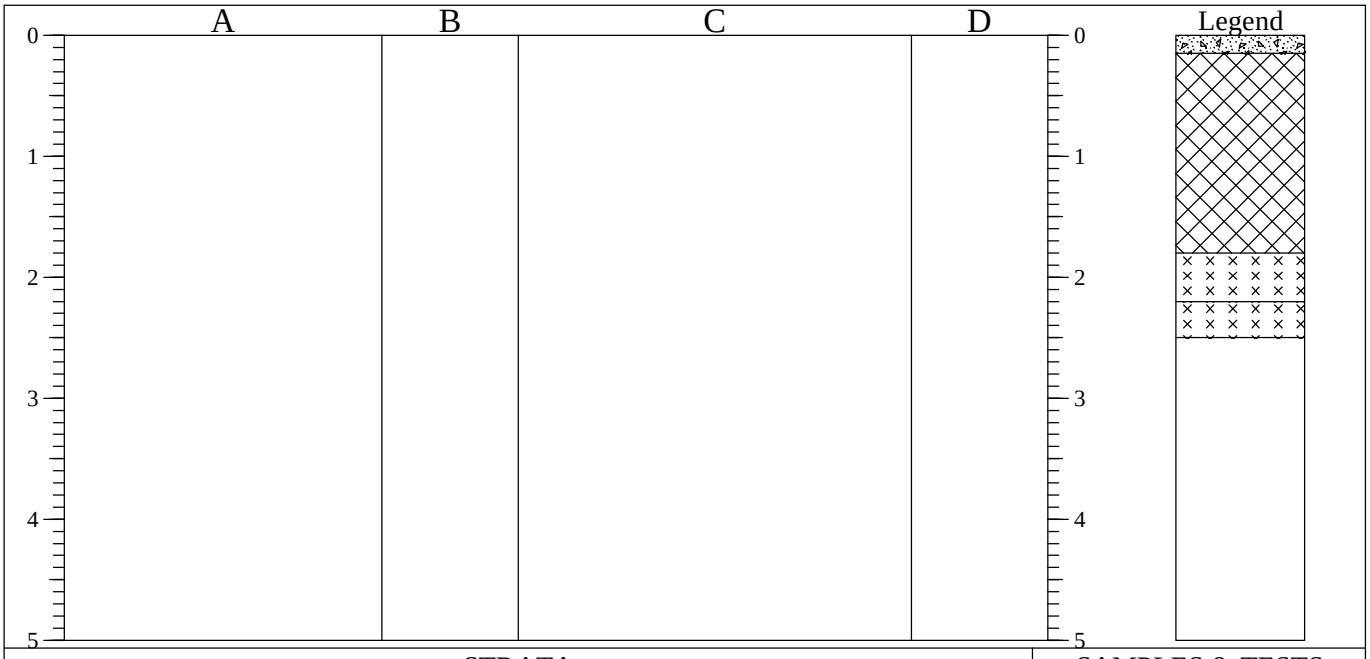
| All dimensions in metres Scale 1:62.5 | Client McCarthy & Stone Retirement Lifestyles | Method/ Plant Used JCB 3CX | Logged By MR |
|---|---|---|---|

AGS3 UK TP 16-075 LOGS.GPJ AGS3_ALL.GDT 5/4/16

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

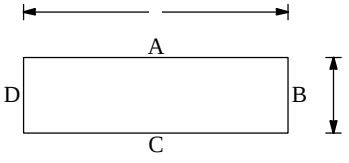
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP04** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| 16-075 | 01-02-16 | | | |
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.15 | | Reinforced concrete with 20mm rebar (MADE GROUND). | | | |
| 0.15-1.80 | | Brown black very ashy sand with concrete and bricks (MADE GROUND). | 0.20 | J/D | |
| | | | 1.00 | J/D | |
| 1.80-2.20 | | Light brown grey completely weathered SILTSTONE. Siltstone recovered as a firm sandy silt (LOWER COAL MEASURES). | 2.00 | D | |
| 2.20-2.50 | | Light brown grey weathered SILTSTONE (LOWER COAL MEASURES). | 2.00 | V | 46 kPa |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

| All dimensions in metres Scale 1:62.5 | Client McCarthy & Stone Retirement Lifestyles | Method/ Plant Used JCB 3CX | Logged By MR |
|---|---|---|---|

AGS3 UK TP 16-075 LOGS.GPJ AGS3_ALL.GDT 5/4/16

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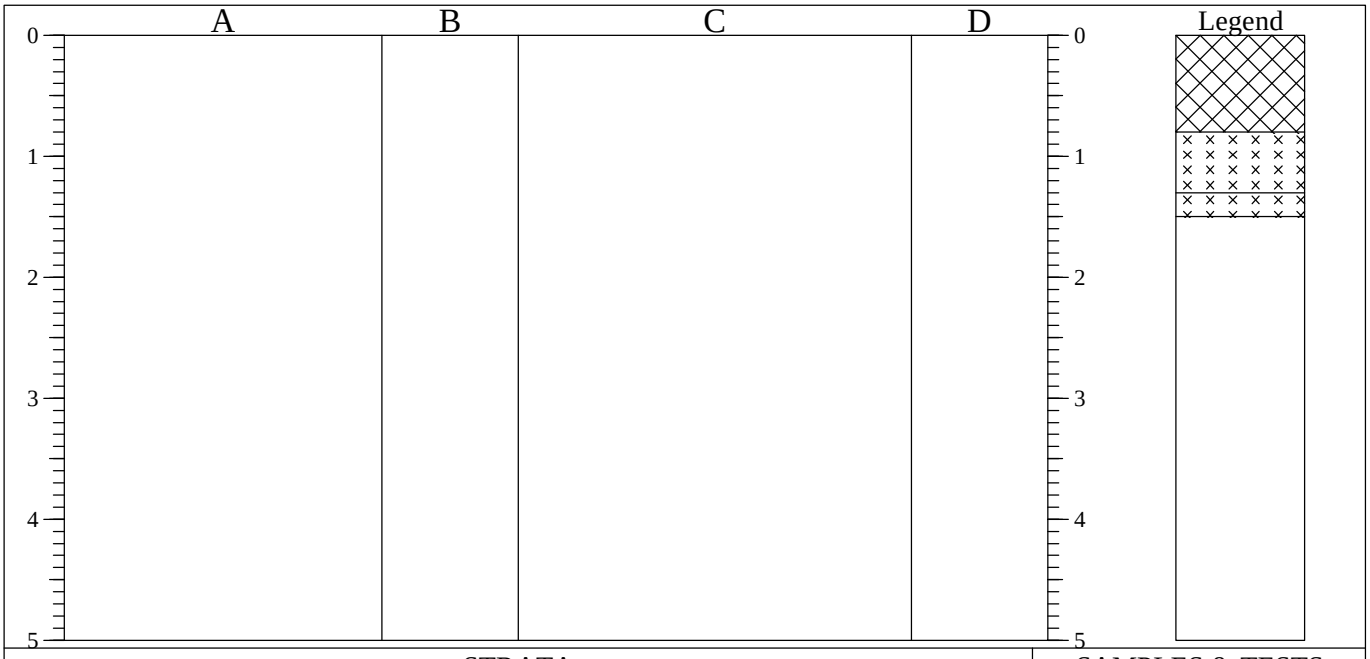
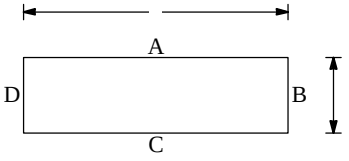
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP05** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| 16-075 | 01-02-16 | | | |
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.80 | | Black very ashy gravelly sand with coal, fragements of bricks and concrete (MADE GROUND). | 0.20 | J/D | |
| | | | 0.70 | J/D | |
| 0.80-1.30 | | Light brown grey completely weathered SILTSTONE. Siltstone recovered as a firm sandy silt (LOWER COAL MEASURES). | 1.00 | V | 46 kPa |
| 1.30-1.50 | | Light brown grey weathered SILTSTONE (LOWER COAL MEASURES). | 1.20 | D | |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

| All dimensions in metres Scale 1:62.5 | Client McCarthy & Stone Retirement Lifestyles | Method/ Plant Used JCB 3CX | Logged By MR |
|---|---|---|---|

AGS3 UK TP 16-075 LOGS.GPJ AGS3_ALL.GDT 5/4/16

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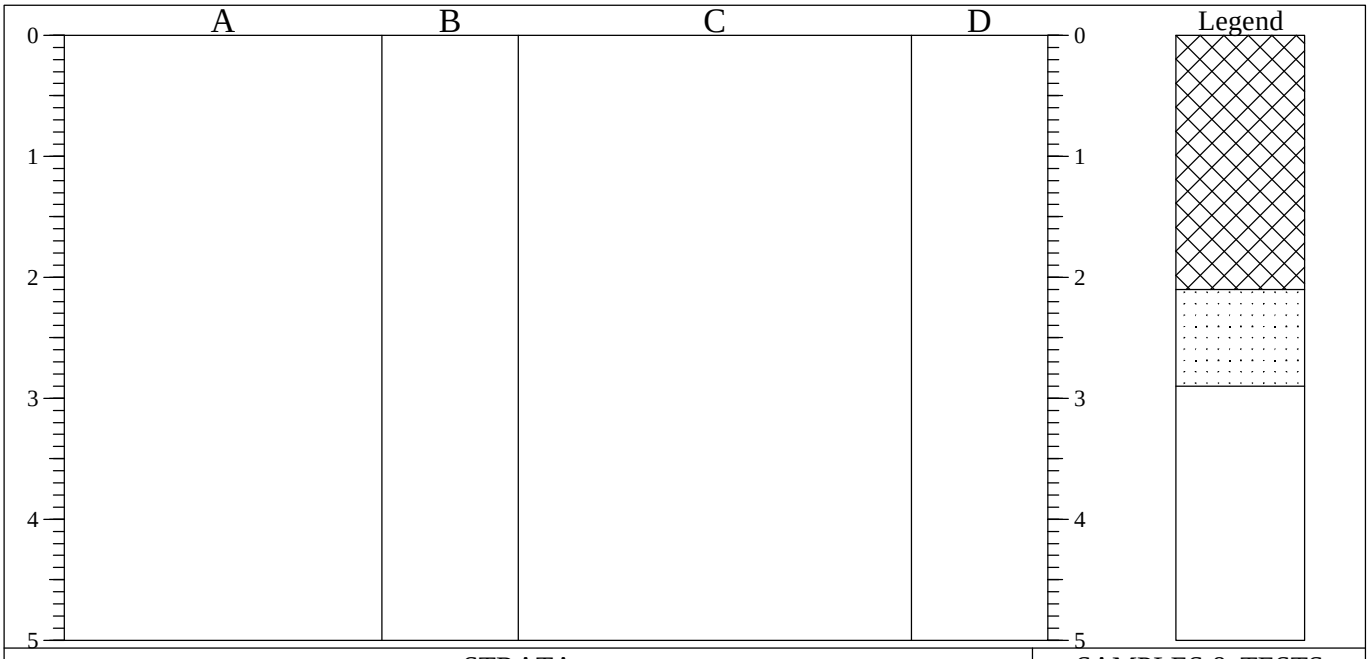
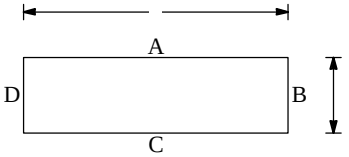
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP06** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| 16-075 | 01-02-16 | | | |
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-2.10 | | Light grey gravelly sand with bricks and fragments of concrete with occasional red brown clay inclusions (MADE GROUND). | 0.50 | J/D | |
| | | | 1.50 | J/D | |
| 2.10-2.90 | | Light brown fine weathered SANDSTONE (LOWER COAL MEASURES). | 2.50 | D | |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

| All dimensions in metres Scale 1:62.5 | Client McCarthy & Stone Retirement Lifestyles | Method/ Plant Used JCB 3CX | Logged By MR |
|---|---|---|---|

AGS3 UK TP 16-075 LOGS.GPJ AGS3_ALL.GDT 5/4/16

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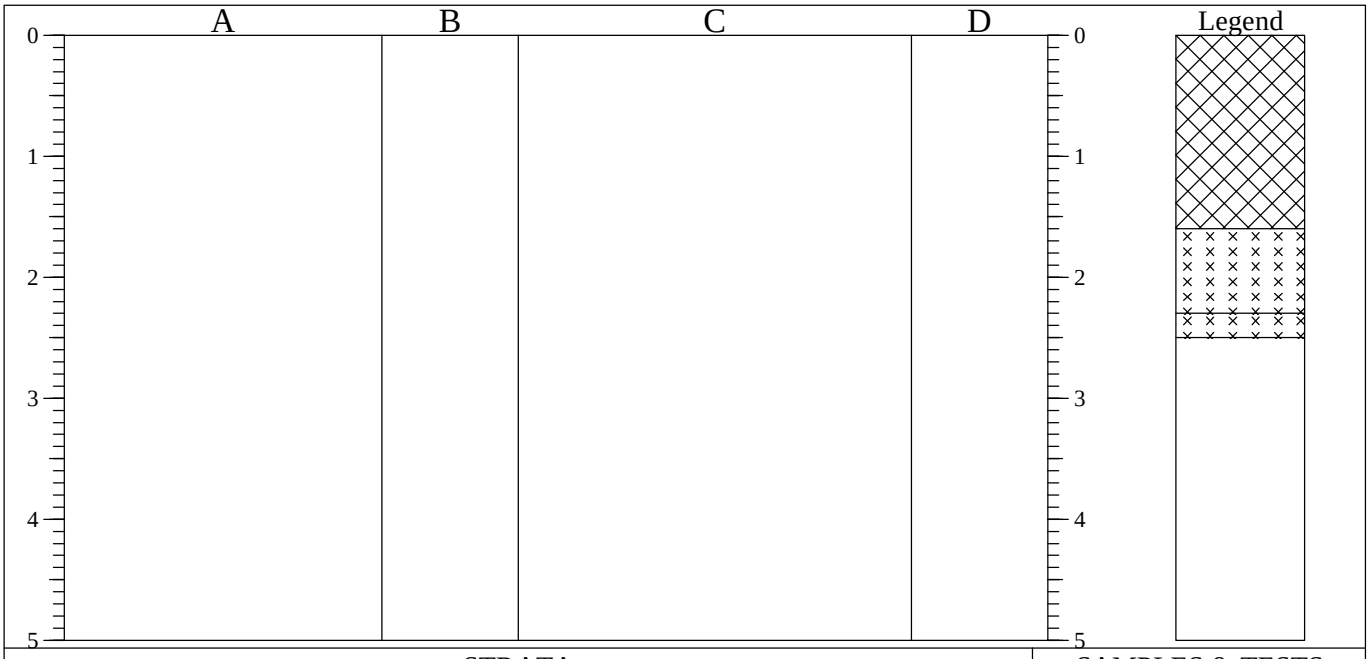
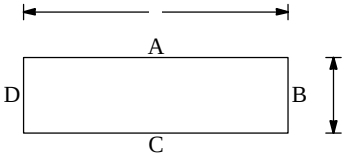
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Serpentine Road, Cleckheaton | | | | **TP07** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| 16-075 | 01-02-16 | | | |
| Contractor | | | | Sheet |
| Arc Environmental Ltd | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-1.60 | | Black very ashy gravelly sand with coal, fragements of bricks and concrete. Slight hydrocarbon odour noted (MADE GROUND). | 0.20 | J/D | |
| | | | 1.50 | J/D | |
| 1.60-2.30 | | Light brown grey completely weathered SILTSTONE. Siltstone recovered as a firm sandy silt (LOWER COAL MEASURES). | 1.80 | V | 54 kPa |
| 2.30-2.50 | | Light brown grey weathered SILTSTONE (LOWER COAL MEASURES). | 2.30 | J/D | |

Shoring/Support:
Stability: Trial pit walls remained stable.





GENERAL REMARKS

No water encountered.

| All dimensions in metres Scale 1:62.5 | Client McCarthy & Stone Retirement Lifestyles | Method/ Plant Used JCB 3CX | Logged By SDT |
|---|---|---|---|