



**ARP ASSOCIATES  
CHARTERED CONSULTING ENGINEERS**

**GEO-ENVIRONMENTAL SUMMARY AND ASSESSMENT  
OF THIRD PARTY INFORMATION**

**AT**

**FORGE LANE  
DEWSBURY**

**ON BEHALF OF**

**MR PATEL**

**FEBRUARY 2016**

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**Introduction**

1. Several third party Geotechnical Engineering Companies have investigated the site, and assessed the contamination status and geotechnical properties of the underlying soils and rock. In October 2011, Arcadis assessed all the existing documents, and site proposals, to produce an "Assessment Findings Summary & Outline Development Constraints and Outline Remedial Strategy" (Issue 3).
2. In August 2013, ARP Geotechnical Ltd reviewed this document and produced a Proposed Contamination Method Statement, under reference 1286/01/REM.
3. Subsequently ARP Geotechnical Ltd was commissioned to produce this assessment, detailing the abnormal requirements of the proposed development. The document is to be provided to a suitable experienced Quantity Surveyor (QS) with other information in order to provide an authoritative and accurate assessment of the likely costs. This assessment is based on the third party information, and ARP Geotechnical Ltd does not accept any liability for any inaccuracies or omissions of the third party information.
4. The proposed development generally comprises two storey residential properties with associated gardens and access roads. The scheme also includes an Extracare apartment block located in the southwestern corner of the site. The pond, drainage ditch and many of the existing trees are to be retained.

**Site Description**

5. The western third of the site is predominantly covered by hardstanding, associated with demolished structures previously located in this part of the site. The remainder of the site is covered with rough vegetation, which is dense in several areas. A pond is located in the southern central portion of the site and a surface water ditch is also present in the eastern part of the site. The site is bounded to the northeast by the Calder and Hebble Navigation, and to the northwest by Forge Lane. Allotment gardens are present to the south and residential development to the east.

## **Site History**

6. The site has historically been split into two sections. The eastern part has been generally undeveloped, with embankments and earthworks taking place from the mid-20th Century to present. The western part of the site has been used for industrial purposes from before the mid-19th Century, when a glass works was present. The works expanded towards the centre of the site, and by 1908, a gravel pit was marked in the southern-central portion of site. By the 1920s, the northern portion of the glass works had been changed into the "Thornhill Iron and Steel Works" with the gravel pit now marked as a pond feature. By the middle of the century, the glass works had been fully replaced by the iron and steel works. The main factory buildings underwent several changes until the late 1980s, when they were demolished.

## **Geology and Coal Mining.**

7. The geological map (BGS map sheet SE21NW) indicates the site to be underlain by Recent and Pleistocene Alluvium, overlying undifferentiated River Terrace Deposits. Mudstones and sandstones of the Lower Coal Measures underlie the superficial deposits. Two coal seam outcrops are conjectured to cross the site in a north to south direction, cutting the site into approximately equal thirds. The western seam is unnamed and recorded as being up to 0.4m in thickness, and the eastern seam is the Green Lane or Middleton Little seam, recorded as being 0.3m to 0.7m thick. The strata dip is probably to the northeast.
8. The third party reports included assessment of a Coal Authority Coal Mining Report, and this indicates that coal is believed to be present at or near the surface which may have been worked in the past. Five rotary boreholes were subsequently drilled, to depths of between 32m and 40m, and these indicated a significant seam between 1.1m and 1.8m thick, which in the southwest of the site, did not have the required 10 times seam thickness of rock cover to protect the proposed development against any void migration from possible workings (only 9.8m of rock cover was present at RP105, where 14m would need to be present). Although there was no indication that the seam had been worked (and workings are considered unlikely, as the challenges of working the seam would be significant for shallow, early history coal mining), five boreholes does not provide sufficient confidence that workings are not present, and further rotary boreholes are recommended. As stated, however, the likelihood at this stage is that workings are not present.

## **Environmental Data**

9. The site is located over a Secondary 'A' Aquifer. The site is not located within a source protection zone. Groundwater was found to be present within the shallow natural deposits, comprising a single groundwater body at depths of between 0.44m and 3.13m in March 2011. This data indicated a flow direction generally to the north to northeast.

10. There are two surface water features located on site:- a pond and a ditch (which is culverted in part). The Calder and Hebble Navigation forms the northeastern boundary. The River Calder is located approximately 500m to the west of site at its nearest point.
11. There are no sensitive groundwater or surface water abstractions within 1km of the site.
12. Gas monitoring has indicated that CS<sub>2</sub> ground gas conditions (equivalent to NHBC Amber 1) apply on the site. Therefore, low level gas protection of properties, against carbon dioxide, is required.

### **Ground Conditions**

13. Third party investigations have identified made ground, overlying Alluvium and River Terrace Deposits, resting upon Lower Coal Measures strata. The made ground was found to be a mixture of materials, and across the majority of the site, ranged in thickness from between 0.3m and 3.5m. In the area of the backfilled gravel pit, deeper made ground was identified, comprising very soft black clay and silt to a depth of 4.8m. The Alluvium extended to depths of between 1.0m and 4.0m, and comprised soft to firm clay, silty clay and clay/silt with occasional plant matter and gravel. The River Terrace Deposits were generally medium dense or dense granular deposits, although occasional clay layers were noted. The River Terrace Deposits extended to depths of between 7.0m and 10.7m. Near the surface, the Lower Coal Measures strata were described as firm to stiff brown clay with occasional gravel and cobbles. With increasing depth, this graded into mudstone with occasional sandstone units and coal seams.
14. The proposed development is constrained by a number of existing underground utilities, including culverted watercourses, sewers and at least one water main.

### **Contamination Assessment**

15. Soil, leachate, sediment, surface water and groundwater samples were analysed during the site investigations, for a broad range of potential contaminants. A number of elevated determinands were identified in soils at the site. In addition, elevated concentrations of PAH compounds in groundwater, sampled from the western part of the site, and ammoniacal nitrogen in groundwater from the site and from a canal water sample were recorded. Generally, the soil leachate and groundwater results indicated no significant linkage between elevated concentrations in soils leaching to groundwater. From testing on sediments sampled from the pond, there is no evidence of a significant risk to the pond (or from exposure to the pond) based on the understanding that the pond is unlikely to be used for recreational purposes or fishing. The potential for human health receptors to come into regular contact with either the sediments or surface water is minimal.
16. Asbestos cement sheeting fragments were identified at surface in the western part of the site, probably partly originating from the demolition of the former buildings in this area of the site, but also from fly tipping at the site.

## Contamination Remediation

17. The risk assessment carried out by third parties has indicated that the following contamination remedial measures should reduce risks from the contaminants on site to acceptable levels. However, the proposals will be subject to the agreement of the Regulatory Authorities:
- 17.1 Where possible, asbestos cement sheeting fragments should be collected and removed from site by appropriately licensed contractors. Material originating from the area of the site where asbestos cement sheeting was observed should not be used in the cover layer. Any areas of Japanese Knotweed should be appropriately treated at this time.
- 17.2 The mounds to the south and north of the pond should not be re-used in a cover blanket without further testing.
- 17.3 It should be assumed that all materials present on the site require either placement or retention below hardstanding or building footprints, or placement beneath an uncontaminated cover blanket of a minimum 0.6m thickness in garden and soft landscaped areas.
- 17.4 The cover blanket to be provided in soft areas on the residential site should be free of all foreign matter, and comply with the specification below.

Thickness (mm)	Description
150	Topsoil
450	Subsoil

- 17.5 If any material is disposed from site to a licenced facility, a Waste Acceptance Criteria (WAC) analysis will need to be undertaken in a UKAS accredited laboratory before removal from site.

## Foundations

18. The existing made ground across the site, the alluvium and the peat deposits, are not considered suitable for support of foundation loads. To reach suitable founding strata (the terrace gravels or weathered coal measures), foundation excavations would be deep and at significant risk of water ingress and instability. In addition, areas on the east of the site are being raised by around 1.5m. It may be possible to re-engineer materials to provide raft foundations, or utilise ground improvement techniques such as vibro stone columns, but there are drawbacks and geotechnical risks with such methods, such as the timescales involved, disturbance of contamination, providing pathways for peat gases to migrate to the surface, and potential for excessive total and differential settlements from soft clay and peat. It is considered likely that the use of piled foundations across the site will provide a more reliable and economical solution, subject to confirmation (by rotary investigation) that the shallow coal seam beneath the site has not been worked. The

advice of a piling specialist should be sought, and allowance may need to be made for pre-drilling through localised obstructions.

### **Road Pavement**

19. For any areas of road pavement, it is recommended that the road line is excavated to a depth of 1m below proposed finished road levels, the base of the excavation proof rolled, and granular material, ideally 6F2 grading, placed and compacted to the underside of subbase level, to a controlled specification. It is likely that a significant portion of the required granular material can be site won, from crushing of existing surface slabs, and from crushing/screening made ground arisings.
20. There is an area of backfilled former gravel pit, approximately 40m x 40m in plan, which contains a significant thickness of soft material. This area should be surcharged using on-site soils at the earliest opportunity, if any road is to cross this area, and settlement monitored, probably using scaffold poles founded on base plates at existing levels. Once settlement rates are within acceptable limits, then remove the surcharge and re-engineering to a depth of 1.5m below proposed level should be carried out, as per section 19 above, except that a geogrid should be introduced at the base of the excavation, extending 10m beyond the backfilled pit, along the road alignment.

### **Cut and Fill**

21. On all areas of the site, where existing made ground is present, 0.6m clean subsoil and topsoil cover is required in garden/landscape purposes for protection against contamination. This cover is not required below building footprints or hardstanding/roads.
22. A detailed cut and fill assessment is not within the remit of this document, but it is understood that there is a requirement to raise levels by around 1.5m on the east of the site, and 0.15m on the west, and that this will require 6,600m<sup>3</sup> of imported material. It would, therefore, be sensible to move existing made ground from the west of the site onto the east, to a maximum level of 0.6m below finished garden/landscape levels. Therefore, the east of the site should accommodate 0.9m thickness of made ground moved from the western areas. It is not clear if this will lower the western area sufficiently to allow placement of the full 0.6m thickness of clean soil in gardens/landscaping, but will assist in this purpose. If required, either proposed garden levels will need to be raised slightly, or levels lowered by removal of material off site (for example the coarse fraction of the made ground could be screened out and crushed, possibly to create 6F2, and this could be used on other sites).

### **Chemical Precautions**

23. The Aggressive Chemical Environment for Concrete (ACEC) class is AC-2 for the site. Therefore, the use of FND2 designated concrete will be required for unreinforced buried concrete, in accordance with BS 8500-1:2006. For reinforced concrete, other design-specific mixes will apply.

## Soakaways

24. The disposal of surface water using soakaways is unlikely to be practical on the site.

## Summary of Geo-environmental Abnormal Cost Items

25. In the light of all the above, abnormal items relating to the proposed development are listed on the table below, with an appropriate column for the Quantity Surveyor to enter approximate costs.

Item	Remediation Requirement	Cost (£)
1	Service location, disconnection and/or protection.	
2	Protection of any trees to be retained.	
3	Inspection, treatment and removal of Japanese Knotweed	
4	Surface litter of asbestos cement sheeting fragments (on western quarter of site) to be collected and removed by appropriately licensed contractor(s).	
5	Site clearance of all vegetation .	
6	Floor slabs to be broken out and crushed, buried structures to be removed and crushed to 1m below finished levels on road areas.	
7	Removal of made ground containing significant slag content to be removed from below building plots and roads in the area of TP11 and TP112. The material should be retained in garden/landscape areas.	
8	Move, place, and compact made ground from the west of the site to the east, to levels 0.6m below garden/landscape areas, possibly shallower below roads and plots.	
9	Import uncontaminated topsoil/subsoil for 0.6m thickness of cover in garden and landscape areas, and granular material for roads, to make up shortfall of site won material. (Based on Arcadis figures, volume of fill to be imported is approximately 6,621m <sup>3</sup> . Assume for pricing purposes 30% of this total will be granular fill, rest will be topsoil and subsoil).	
10	Excavate proposed roads to a depth of 1m below proposed levels, proof roll, placed and compact and granular material, ideally 6F2 grading, to the underside of subbase level. It is likely that a significant portion of the required granular material can be site won, from crushing of existing surface slabs, and from crushing/screening made ground arisings.	

11	If any road is to cross the backfilled gravel pit, place surcharge material and monitor settlement. Once settlement rates are within acceptable limits, then remove and re-engineer to a depth of 1.5m below proposed level, with geogrid at the base of the excavation, extending 10m beyond the backfilled pit, along the road alignment.	
12	Use piled foundations for all buildings on the site, subject to confirmation that the underlying shallow coal seam has not been worked.	
13	Place 0.6m cover of soils around buildings as they are nearing completion, with contamination validation.	
14	Independent supervision and validation report for re-engineering works for road areas, and contamination remediation.	
15	Any deep excavations may require groundwater control, e.g. well point dewatering. Appropriate discharge consents will be required.	