STAGE 2 GEO-ENVIRONMENTAL REPORT

AT

106 GREENFIELD ROAD

HOLMFIRTH

ON BEHALF OF

H H SERVICES LTD

ARP GEOTECHNICAL LTD

CHARTERED CONSULTING ENGINEERS

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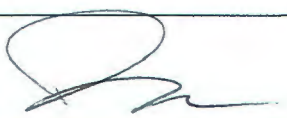
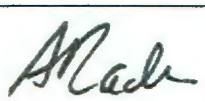
Reviewed By:	J Race BSc CGeol FGS EurGeol	
Authorised By:	A Radcliffe BEng CEng MIStructE	

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1	7th DECEMBER 2018	V1 FINAL

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1.0 EXECUTIVE SUMMARY

The pertinent conclusions of the report are tabulated below. However, the information below is not exhaustive, and it is recommended the report is read in its entirety.

Proposed Development	Residential dwellings with private gardens and access road.
Existing Site Description	Detached house with private garden at centre, a workshop on the south and fields to the north and southeast. Steeply sloping, with retaining walls present.
Site History	Workshop on the south since 1850s, glazed structure at centre of site from 1930s until 1990s, detached house at the centre from 1960s. Well indicated in northwestern corner since 1900s.
Geology	Sandstone of the Guiseley Grit Formation on the north, undifferentiated mudstone, siltstone and sandstone of the Marsden Formation on the south. No drift deposits.
Coal Mining	Site can be considered stable.
Radon	Basic radon protection measures recommended.
Landfill Gas	Old landfill 160m southeast of the site, and refuse tips indicated nearby on for a short time on archive maps. However, lines of evidence indicate minimal risk from landfill gas and monitoring is not considered necessary (subject to regulator agreement).
Ground Conditions	Made ground generally absent, locally present up to 2.1m thick, overlying cohesive and granular residual soils and intact bedrock.
Contamination	No contamination identified. No remedial measures required.
Foundations	Strip/trench foundations. Tree survey required.
Excavations	Excavations likely to be stable. Hydraulic breaker likely to be required for excavations into intact bedrock.
Concrete	GEN1 designation for unreinforced buried concrete. For any reinforced concrete, other design-specific mixes will apply.
Soakaways	Not considered viable due sloping ground and requirement for retaining walls within the proposed development.

Road Pavement	A design CBR value in excess of 15% is considered applicable on the residual granular soils across much of the site. Potential deep made ground associated with infilled basement of existing workshop likely to prevent a natural formation to the south - engineering measures required.
Retaining Structures	Existing retaining walls are present along the northern and southern boundaries. Highways approval required for any alterations to the existing retaining wall along the southern boundary. Additional retaining structures will be required to accommodate proposed level.
Other constraints	Well in northwest corner of the site may need to be backfilled.

2.0 TERMS OF REFERENCE

2.1 H H Services Ltd is considering developing the site at 106 Greenfield Road, Holmfirth with residential properties with private gardens. It was considered appropriate to provide information to aid viability assessment and design of any subsequent development. ARP was provided with a copy of a Desk Top Study Report (NG8557/GRE), dated April 2014, by JNP Group Consulting Engineers, on behalf of Mr Robert Brook, to which the Client had, or would be, obtaining reliance. The report comprised an assessment of the geological and coal mining aspects, Ordnance Survey archive maps, radon gas, indicative flood risk, hydrogeology, landfill, and other environmental issues. In addition to comments and conclusions on a range of environmental and geotechnical issues, the report also provided recommendations for intrusive investigation and assessment.

2.2 In November 2018, ARP Geotechnical Ltd was appointed by H H Services Ltd to undertake a Stage 2 Intrusive Investigation, comprising trial pits, to assess the ground conditions.

2.3 The investigation was implemented generally in accordance with BS 5930 : 2015 "Code of practice for site investigations", NHBC Standard Chapter 4.1 "Land quality - managing ground conditions", Environment Agency CLR 11 "Model Procedures for the Management of Land Contamination" and BS10175 : 2011 + A2 : 2017 "Investigation of potentially contaminated sites - Code of practice". This report is limited to the data obtained as part of this investigation. It should be noted that there is a possibility of variation in ground conditions between test locations and interpretation of strata is given for guidance only. No liability is accepted for changes to site conditions, including groundwater levels, after the preparation of this report.

2.4 The findings or contents of the Stage 1 Desk Study Report are not reproduced here in full, and it is recommended that this report is read in conjunction with the Stage 1 Report.

2.5 The general observation and assessment of the ground surface, and the identification/classification of vegetation is made in general terms only. It would be prudent

for a specialist to undertake a more detailed survey, including for any invasive/harmful weeds.

2.6 The assessment of any topsoil is carried out in terms of potential chemical effects on human health only, and no account is taken of aesthetic or horticultural properties. Such considerations should be referred to a horticulturist or landscape architect.

2.7 The report has been prepared for the use and reliance of the Client only. The report shall not be relied upon or transferred to any other parties without the written agreement of ARP Geotechnical Ltd. For the avoidance of any doubt, where ARP Geotechnical Ltd enters into a letter of reliance for the benefit of a third party, that third party will be permitted to rely on the report. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party without ARP Geotechnical Ltd.'s consent.

3.0 THE SITE

Site Location

3.1 The site, which is centred on Ordnance Survey Grid Reference SE 13333 07943, is located at 106 Greenfield Road, Holmfirth.

3.2 A site location plan, aerial photograph, and indicative proposed site layout, are presented in Appendix A.

Site Description

3.3 The site currently comprises a split level stone workshop on the south, at the boundary with Greenfield Road, and a detached residential property (Little Croft) with terraced garden towards the centre. The workshop is surrounded by hardstanding of concrete and bituminous surfacing ("bitmac") with a small stockpile of rubble and other debris, including car tyres, immediately east of the workshop. It is understood that the workshop includes an infilled basement. The remainder of the site comprises rough grassed fields with numerous mature trees along the boundary and towards the northern end of site. Access to Little Croft is up a steep bitmac drive rising from Greenfield Road.

3.4 In the northwestern corner of the site, a possible covered well is present, at the approximate location of a well shown on historical maps. The ground surrounding the well was very boggy, with the wheels of the excavator sinking when driving across this area. The third party desk study indicates that the will is in fact two stone cattle troughs, fed by a 150mm diameter clay pipe from the northwest. Following further development in the area, the troughs are reported to have dried up, but the area south of the trough remained boggy from probable spring water higher up the slope.

3.5 An elongated manhole cover (possibly a vehicle inspection pit) was present immediately west of the workshop.

3.6 The site slopes significantly by approximately 16m from the north, down towards Greenfield Road to the south. Potentially infilled ground is present immediately east of the workshop. An approximately 0.8m to 1.4m high dry stone retaining wall is present along the northern boundary, retaining residential gardens at a higher level off site. The wall was partially damaged towards the north-centre of the site. Various retaining structures are present along the southern boundary with the pavement of Greenfield Road, retaining higher ground on site. The retaining wall is generally stone and is between 1.5m high in the east and 2.5m in the west. The existing workshop is likely to be a retaining structure.

3.7 The site is bounded to the north by a dry stone retaining wall with private gardens beyond, to the south by a various retaining structures including the workshop along the pavement of Greenfield Road, to the east by hedgerows with residential properties beyond and to the west by wooden fences and hedges with residential properties beyond.

3.8 Photographs taken during the site walkover are presented in Appendix B.

Site History

3.9 Ordnance Survey archive maps show that the building at the southern boundary has been present since the 1850s. Little Croft has been on site since the 1960s with a glazed structure shown adjacent to Little Croft between the 1930s and 1990s. A well was shown in the northwest corner of the site from 1900s. Two refuse tips were shown approximately 20m and 130m south of the site on the 1964 historical map. Other significant land uses within 250m of the site include a dye works, iron works, several mills and a cattle market, all down gradient of the site.

4.0 ENVIRONMENTAL SETTING

4.1 The environmental setting for the site was established by the Desk Top Study Report undertaken by JNP Group Consulting Engineers Report reference NG8557/GRE, dated April 2014, The findings of the Desk Study Report, updated and amended where deemed appropriate, are summarised below.

Geology

4.2 The geological maps show the site to be underlain by undifferentiated mudstone, siltstone and sandstone of the Marsden Formation across much of the site, with sandstone of the Guiseley Grit formation on the northern end of the site. There are no faults shown to affect the site.

Coal Mining

4.3 The third party Desk Study Report indicates the site is stable with regard to coal mining.

Hydrogeology

4.4 The Landmark Envirocheck Report indicates the Bedrock Aquifer Designation to be "Secondary A" Aquifer.

4.5 There nearest groundwater abstraction license is 192m to the south of the site and used for general industry, though the license has been revoked.

Hydrology

4.6 There are no watercourses on or adjacent to the site. The nearest watercourse downslope is a pond 14m southwest of the site. The river Holme is located approximately 190m southeast of the site. Any surface water run-off is likely to enter the road drainage on Greenfield Road to

the south of the site, eventually reaching the River Holme approximately 190m southeast of the site. The site is not in an area at risk from river flooding.

Other Relevant Environmental Data

4.7 There is one recorded licenced landfill within 1km of the site. The historical landfill is located 165m southeast of the site and accepted inert and commercial waste at the Perseverance Mill site. This historical landfill is located at an approximately 40m lower elevation than the site, therefore the risk of migration towards the site is considered to be negligible.

4.8 Historical maps indicate that two "refuse tips" were present at 20m and 130m south of the site (1964 map). At the location of the nearest refuse tip, allotments were present prior to 1964 with no evidence of any large scale excavation (e.g. quarry, clay pit etc.). The refuse tip was no longer shown by 1977 but there was evidence of re-profiling in the far north. The site was redeveloped for housing in the 2000s. The furthest refuse tip (130m south) was part of the Victoria Iron Works from the 1900s, with evidence of a refuse heap present from the 1930s. This location has since been redeveloped as residential properties. Based on the site history, the refuse tip furthest from the site (130m south) is likely to be a spoil heap of material derived from the iron works process (probably largely inert slag and other debris). Due to the absence of any large scale excavations (i.e. a quarry or clay pit) prior to the presence of the nearest refuse tip (20m south), the refuse material is likely to have been deposited above ground. Furthermore, based on its proximity to Victoria Iron works, and the lack of space on the iron works site for further fill, it is considered likely that the material placed also comprised iron works waste. As the material is probably inert and placed above ground, and given its age (and that all these areas are now covered by residential properties), ongoing ground gas generation potential is considered to be negligible.

4.9 No radon protective measures are stated to be necessary for new dwellings or extensions on the site. However, the site is in an intermediate probability radon area. In these circumstances of apparent conflict, it may be prudent to assume basic radon protection is

required, to prevent conveyancing difficulties. This is normally achieved by incorporating a radon barrier within a solid floor system, and extending the barrier through the cavity wall.

4.10 The site is not within an area at risk from river flooding.

Potential Contamination Sources

4.11 The following potential sources of contamination were identified by the JNP Desk Top Study Report:

4.11.1 Potential asbestos within existing stone building on the south.

4.11.2 Potential off-site source of landfill gas associated with an historical landfill site 164m southeast of the site and two "refuse tips" shown on archive maps 20m and 130m south of the site. As discussed in Section 4.10, ARP has concluded that the risk from the landfill and the refuse tips are negligible and therefore, no gas monitoring is considered necessary. However, this is subject to the agreement of the regulatory authorities.

4.11.3 Potential off-site sources of contamination associated with an historical landfill site, two refuse tips, dye house and cattle market. However, due to the topography of the area, these were not considered by JNP to be a risk to the site, in terms of contamination.

4.12 In addition to the above, ARP would add the following potential contamination source:

4.12.1 Possible made ground: - metals inorganics, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAH), phenol, asbestos. From the site walkover, made ground was considered likely to be present adjacent to the workshop in the south.

5.0 SITE INVESTIGATION

5.1 A site investigation was undertaken by ARP Geotechnical Ltd on 12th November 2018. The purpose of the investigation was to produce an assessment of the site in accordance with BS10175 : 2011 + A2 : 2017 "Investigation of potentially contaminated sites - Code of practice", and to provide geotechnical information to aid design of the development.

5.2 The site was gridded on a maximum 25m spacing and trial pits were excavated and sampled on the grid, to satisfy the requirements of the British Standard, along with any targeted locations. Thirteen trial pits (TP1 to TP13) were excavated, to depths of between 2.2m and 3.9m. In addition, an approximate in situ CBR reading was taken, using a MEXE Cone Penetrometer, in TP11 beneath the subbase. The trial pits were organised, supervised and logged by an Engineer from ARP Geotechnical Ltd. Justifications for the trial pit locations are given below.

LOCATION	REASON
TP1 to TP5	Part of grid within the field in the northwest corner of the site
TP6 toTP8	Part of grid within the field in the north
TP9, TP10 and TP12	Part of grid within the field in the southeast
TP11	Targeting the edge of the existing driveway
TP13	Target the area of potential infilled ground adjacent to the workshop in the south

5.3 The trial pit location plan and logs are included in Appendix C. It should be noted that the co-ordinates on the logs have not been surveyed in, but are automatically determined by the logging software (which incorporates mapping) following approximate positioning of each location by the Engineer. The level data included on the logs have been extrapolated from the topographical survey (Ellam Land Surveys, Drawing No 4698/1A, Dec 2018). The levels on the topographical survey use a temporary benchmark rather than Ordnance Datum.

5.4 Chemical analysis of ten soil samples for metals, inorganics, speciated PAH, TPH, phenols, and asbestos was undertaken by the UKAS accredited Concept Life Sciences. The test certificates are included in Appendix D.

5.5 Analysis for Atterberg Limits and moisture content together with particle size distribution (PSD) test was undertaken by the UKAS accredited Professional Soils Laboratory (PSL) in Doncaster. Geochemical testing comprising pH and water soluble sulphate was undertaken by DETS. The test certificates are included in Appendix D.

6.0 SUMMARY OF GROUND CONDITIONS

Strata and Groundwater

6.1 The deposits present beneath the site, and the variation in the distribution of the strata, have been analysed with reference to the trial pits (TP). Two geological sections (Section 1 and Section 2) are included in Appendix C, and section lines are marked on the site investigation plan.

6.2 The site investigation revealed a covering layer of topsoil across the majority of the site, between 0.2m and 0.4m thick. Bitmac was identified in TP11 towards the south of the site and was 0.2m thick.

6.3 Made ground was largely absent from site, with the exception of TP7 in the north of the site (down to 1.1m depth) and TP11 immediately adjacent to the workshop in the south (down to 2.1m depth).

6.4 On the north of the site (TP1, TP4, TP6 and TP7) the topsoil (or localised made ground) was underlain by cohesive residual soils to between 1.0m and 1.7m depth, with the exception of TP1, where granular residual soils of sand or gravel were present, to between 2.1m and 2.7m depth. The residual soils are interpreted to derive from the weathering of bedrock of the Marsden Formation. The residual soils were underlain by intact bedrock (Marsden Formation) proven to depths of between 2.2m and 2.9m. The bedrock was recovered as angular gravel, angular, tabular cobbles and boulders of sandstone.

6.5 On the south of the site (TP2, TP3, TP5, and TP8 to TP13) the topsoil, locally made ground, was underlain by granular residual soils of sand or gravel to depths of between 2.8m and 3.4m, and locally by cohesive residual soils to between 1.1m and 1.6m depth. The residual soils are interpreted to derive from the weathering of the undifferentiated mudstone, siltstone and sandstone of the Marsden Formation. The residual soils were underlain by intact bedrock (Marsden Formation) proven to depths of between 3.5m and 3.9m. The sandstone and

siltstone was recovered as angular and tabular gravel, cobbles and boulders. Intact bedrock was not proven in TP8 to TP13.

6.6 The excavations generally remained stable for the short period of exposure and the pits were backfilled with the arisings on completion. No significant groundwater ingress was encountered during the site investigation, although soils were locally moist at between 2.3m and 3.4m depth.

7.0 CONTAMINATION ANALYSIS

Screening Values - Soils

7.1 There is presently conflicting opinion with regard to the appropriate generic assessment criteria, or screening values, for soils which should be used in contamination assessment for proposed development. In March 2014, DEFRA published Category 4 Screening Levels (C4SLs) for six contaminants: arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead. The values are based on the toxicological benchmark of a "low level of toxicological concern" (LLTC) rather than the previous regulatory approach of "minimal or tolerable level of risk". As the C4SLs are less protective of health than the previous approach, the Chartered Institute of Environmental Health (CIEH) has advocated an alternative approach based on minimal risk, but with some adjustment of exposure parameters to more realistic scenarios than those previously used. To this end, the CIEH has collaborated with Land Quality Management to publish "Suitable 4 Use Levels" (S4ULs) "The LQM/CIEH S4ULs for Human Health Risk Assessment", November 2014 (LQM/CIEH). However, DEFRA has reiterated its intention that the C4SLs should be used in generic risk assessment for proposed development, and there is indication that other parties will collaborate, in the near future, to extend the range of C4SL determinands beyond the six published so far.

7.2 In the absence of a final resolution to the debate, soil contamination test results in this report have been compared first against the more conservative S4UL, and where a C4SL exists for the same determinand, consideration given to the use of the C4SL for any exceedences of the S4UL, within the site specific context. Where no S4UL exists for a determinand, for example lead, the C4SL has been used. The LQM/CIEH screening values have been calculated for soil organic matter contents of 1% and 2.5%, as well as 6%, and the appropriate screening value is used for the organic matter content of the soil. All the C4SL values published are for a soil organic matter content of 6%.

7.3 A table showing the screening values utilised is included in Appendix C.

Soils Analysis

7.4 Ten samples were issued to Concept Life Sciences for the suite of testing (As, Cd, Cr (VI), Cr(III), Cu, Hg, Ni, Pb, Se, Zn, Total Sulphate, Water Soluble Sulphate, pH, Phenol-monohydric, Speciated PAH, Total TPH, Asbestos, and Organic Matter). The testing comprised:

- Eight samples of topsoil from TP1, TP3, TP4, TP5, TP6, TP8, TP10 and TP12
- Two samples of made ground from TP7 and TP13

7.5 No tested concentration of determinands was found to exceed the residential screening values in any of the samples and no asbestos was detected. No remedial action is, therefore, necessary with regard to contamination.

Updated Risk Assessment and Conceptual Model

7.6 The conceptual model can be updated to take account of the findings of the site investigation and laboratory tests. The main refinements are given below.

7.6.1 Contamination testing of the topsoil and made ground revealed all determinands to be below current best practice screening values for residential use, including private gardens in which produce may be grown and subsequently eaten.

7.6.2 There is a closed registered landfill 160m southeast, and refuse tips 20m and 130m to the south. However, given their age, likely nature, the local topography and development history, it is concluded that the risks of landfill gas migration into the site are negligible and therefore, no gas monitoring is considered necessary. This is subject to the agreement of the regulatory authorities. However, basic radon protection measures are recommended for use on the site.

7.6.3 If any imported soils are to be used on the site, these will need to be verified as suitable by inspection and testing, in accordance with guidance supplied in the document produced by the Yorkshire and Lincolnshire Pollution Advisory Group

(YALPAG): "Guidance on the Verification Requirements for Cover Systems". A Method Statement for Assessment of Imported Soils is included in Appendix F.

7.6.4 An asbestos survey should be carried out prior to any demolition of the workshop and Little Croft, and any identified asbestos removed and disposed to a licenced facility. The work should be carried out by appropriately qualified Contractors.

8.0 GEOTECHNICAL TESTING

8.1 Selected samples of the natural strata were delivered to PSL in Doncaster for testing with regard to plasticity indices and moisture content. Test certificates are presented in Appendix D and a summary of the results, including Modified Plasticity Indices, is given below.

Location	Depth (m)	MC	LL	PL	PI	<425µm	I'p
TP3	0.8	22	43	23	20	95	19.0
TP4	0.4	25	66	27	39	97	37.8
TP7	1.50	18	62	25	37	90	33.3
TP9	0.60	16	37	21	16	92	14.7
No. of results		4	4	4	4	4	4
Min.		16	37	21	16	90	14.7
Max.		25	66	27	39	97	37.8

I'p	VCP
>40%	High
20% - <40%	Medium
10% - <20%	Low

MC= Moisture Content (%) LL= Liquid Limit (%) PL= Plastic Limit (%)
PI= Plasticity Index (%) I'p= Modified PI (%) VCP= NHBC Standard Chapter 4.2 Volume Change Potential

8.2 The plasticity test data shows the soils tested to be clays of intermediate to high plasticity, in accordance with BS 5930 : 2015 "Code of Practice for Site Investigations". When the percentage retained on the 425 micron BS sieve is considered, the Modified Plasticity Index, in accordance with NHBC Standard Chapter 4.2 "Building Near Trees" is a maximum of 37.8. In accordance with the Standard, this equates to Medium Volume Change Potential.

8.3 Geochemical testing (water soluble sulphate and pH) was undertaken on selected samples by DETS laboratory, comprising four samples of natural strata and two samples of made ground. In accordance with the BRE Special Digest 1 "Concrete in aggressive ground", the characteristic values for the two materials are as follows:

Characteristic Values

Material	pH	SO_4
Made Ground	5.7	50
Natural Strata	6.1	15

SO_4 = Sulphate content in mg/l on a 2:1 water : soil extract pH = Acidity

8.4 The geochemical analyses show the natural strata and made ground to have low water soluble sulphate content and slightly acidic pH. The Aggressive Chemical Environment for Concrete (ACEC) class is AC-1. Therefore, the use of GEN1 designated concrete will be necessary for unreinforced buried concrete, in accordance with BS 8500-1:2006. For any reinforced buried concrete, other design-specific mixes will apply.

8.5 A particle size distribution test was carried out on a sample collected from TP11, at between 0.6m and 0.8m depth, using the Wet Sieve method in accordance with BS1377 : Part 2 : 1990 Clause 9.2. The test certificate is presented in Appendix D and a summary of the results is given below. It is noted that the cobble content of the soils tested is not recorded, as the focus was on the fine fraction;

- Gravel 69%
- Sand 16%
- Silt/Clay 15%

The results confirm the engineer's site description for this material, of a silty sandy GRAVEL.

8.6 A MEXE Cone Penetrometer was used on natural soils in TP11 at 0.2m beneath the bitmac and subbase, to determine the approximate CBR of the subgrade. A result of over 15% was recorded, which is the upper limit of the device.

9.0 COMMENTS AND CONCLUSIONS

Site Description

9.1 The site currently comprises a split level stone workshop on the southern bounmdary and a detached residential property (Little Croft) towards the centre. The workshop is surrounded by hardstanding of concrete and bitmac, with a small stockpile of rubble and other debris including car tyres immediately east of the workshop. It is understood that the workshop includes an infilled basement. The remainder of the site comprises rough grassed fields with numerous mature trees along the boundary and towards the northern end of site.

9.2 In the northwestern corner of the site, a possible covered well is present, at the approximate location of a well shown on historical maps. The ground surrounding the well was very boggy, There is third party information which indicates the feature is probably two stone cattle troughs, fed by a pipe from the northwest. An elongated manhole cover was present immediately west of the workshop (possible service pit).

9.3 The site slopes steeply down towards Greenfield Road to the south. A dry stone retaining wall, along the northern boundary, retains residential gardens at a higher level off site. Various retaining structures are present along the southern boundary with Greenfield Road, retaining higher ground on site. The retaining wall is generally stone and is between 1.5m high in the east and 2.5m in the west. The existing workshop is likely to be a retaining structure.

Site History

9.4 Ordnance Survey archive maps show that the workshop has been present on site since the 1850s. Little Croft has been present since the 1960s with a glazed structure shown adjacent from the 1930s until the 1990s. A well is shown in the northwest corner from the 1900s.

Geology

9.5 The geological map shows the site to be underlain by undifferentiated mudstone, siltstone and sandstone of the Marsden Formation on the south, and sandstone of the Guiseley Grit Formation on the north. There are no faults shown to affect the site.

Coal Mining and Coal Recovery

9.6 The third party Desk Study Report indicates the site is stable with regard to coal mining.

9.7 There will be no significant arisings of coal during proposed development works, and it will not be possible to win any coal from the site before development.

Environmental Data

9.8 The strata beneath the site are classed as a Secondary A Aquifer. There are no active groundwater abstractions within 1km of the site.

9.9 The nearest surface water is a pond, approximately 14m to the south. However, any surface water run-off is likely to enter the road drainage on Greenfield Road to the south of the site, eventually reaching the River Holme approximately 190m southeast of the site.

9.10 No radon protective measures are stated to be necessary for new dwellings or extensions on the site. However, the site is in an intermediate probability radon area. In these circumstances of apparent conflict, it may be prudent to assume basic radon protection is required, to prevent conveyancing difficulties. This is normally achieved by incorporating a radon barrier within a solid floor system, and extending the barrier through the cavity wall.

9.11 There is a closed registered landfill 160m southeast, and refuse tips 20m and 130m to the south recorded on limited archive maps. However, given their age, likely nature, the local topography, and local development history, it is concluded that the risks of landfill gas

migration into the site are negligible and therefore, no gas monitoring is considered necessary. This is subject to the agreement of the regulatory authorities. However, basic radon protection measures are recommended for use on the site.

9.12 The site is not at risk from river flooding. The risks of flooding from other causes such as adverse topography or insufficient surface water drainage, are not considered here. If such risk needs to be quantified, a separate specialist Flood Risk and Drainage Report should be commissioned, if not already available.

Ground Conditions Encountered

9.13 The ground investigation revealed topsoil across the majority of the site, up to 0.4m thick, with localised bitmac cover 0.2m thick. Made ground was encountered locally, to 1.1m depth in TP7 and 2.1m depth in TP13. Beneath the surface materials, cohesive and granular residual soils (derived from the weathering of bedrock) were identified to between 2.1 m and 3.4m depth, over intact bedrock of sandstone and siltstone. Intact bedrock was not proven in TP8, TP9, TP10, TP11, TP12 and TP13. No significant groundwater ingress was encountered during the site investigation, although soils were locally moist at between 2.3m and 3.4m depth.

Contamination Assessment

9.14 The contamination testing revealed no elevated concentrations of soil contaminants, with respect to human health screening values appropriate for the proposed residential properties. No remediation measures are considered to be required with respect to ground contamination.

9.15 However, to satisfy the regulatory authorities that any unexpected contamination will be investigated and dealt with appropriately, and that the quality of any imported soils will be verified, a Method Statement for the Assessment of Imported Soils is presented in appendix F.

9.16 An asbestos survey should be carried out prior to any demolition of the workshop and Little Croft, and any identified asbestos removed and disposed to a licenced facility. The work should be carried out by appropriately qualified Contractors.

Foundations

9.17 Due to the steeply sloping nature of the site, cut and (potentially more cut than fill) earthworks are likely to be required. To accommodate proposed site levels, many of the plots, particularly in the north are intended to be split level.

9.18 The natural cohesive residual soils (clays derived from complete weathering of the underlying bedrock) are considered suitable to provide support for strip/trench fill foundations, subject to proposed development levels. An allowable bearing pressure of 100kN/m^2 is considered applicable for cohesive residual soils and a bearing pressure of 150kN/m^2 applicable on granular residual soils. A higher allowable bearing pressure of 300kN/m^2 is considered applicable on the intact bedrock.

9.19 Due to the high level of cut likely to be required for the plots on the north, the foundations are likely to be seated onto either residual granular soils or intact bedrock. In the southern end of the site, less cut is likely to be required and, therefore, foundations are likely to be seated on either granular or cohesive residual soils.

9.20 Where present, the clays were shown to be of medium volume change potential. Therefore, in accordance with NHBC Standard Chapter 4.2 "Building Near trees", in the absence of trees, a minimum foundation depth of 0.9m below existing or proposed ground level is applicable, whichever is the lower. However, in the presence of any proposed, existing or removed trees, the foundation may need to be deepened, depending on the type of tree and its distance from the face of the foundation. If not already available, a tree survey may be required to enable a foundation schedule to be prepared. The tree survey will also need to consider trees on third party properties.

9.21 Across much of the site, the founding strata are likely be non-plastic, and, therefore, the minimum foundation depths given in NHBC Standard Chapter 4.2 "Building Near Trees" do not apply. However, to protect against fines washing subsidence in the event of a burst water supply pipe, it is recommended that a foundation depth of 0.9m is adopted in proximity to any such pipes.

9.22 The foundation should be taken below the depth of any existing foundations or obstructions, onto natural ground. The whole plan area of the foundation should be placed on similar natural material. Foundations should be reinforced where it is necessary to transition from suitable granular to suitable cohesive strata within a proposed building footprint.

9.23 If bedrock is encountered on part of a foundation excavation, the rest of the plot should be deepened to ensure founding on similar material. However, if rock is not encountered by 2.5m depth on the remainder of the plot, then the Engineer should be contacted for further advice.

Excavations

9.24 It is likely that excavations into the natural strata will remain stable in the short term, requiring minimal trench support, in accordance with the prevailing statutory guidance. However, instability may be anticipated within any localised made ground present on the site.

9.25 No significant groundwater seepages were observed during the site investigation. However, should groundwater be encountered any such encounters should be controllable by pumping from an artificial sump.

9.26 Excavations should be readily achieved using conventional hydraulic plant. However, excavations into intact bedrock (likely in the north during earthworks), or any buried foundations and structures, are likely to require a hydraulic breaker.

Chemical Precautions

9.27 The Aggressive Chemical Environment for Concrete (ACEC) class is AC-1 for both the natural strata and made ground. Therefore, the use of GEN1 designated concrete will be satisfactory for unreinforced buried concrete, in accordance with BS 8500-1:2006. For any reinforced buried concrete, other design-specific mixes will apply.

Road Pavement Construction

9.28 For any areas of road pavement, including parking areas, the formation will be the residual cohesive or residual granular soils across much of the site. Below any obvious soft spots, and at equilibrium moisture content, a design California Bearing Ratio (CBR) value of at least 15% is considered applicable for the granular soils. However, in the southern end of the access road, made ground is anticipated, associated with the infilled basement of the existing workshop, and this is likely to prevent a formation on natural strata. There are several potential solutions for this situation, including complete excavation of the made ground to natural strata, and placement of engineered fill to controlled specification, or partial excavation and replacement, with layers of geogrid. If any road areas are to be adopted, the proposed measures will need to be agreed with the adopting authority and, therefore, consultations should be undertaken at the earliest stage. Following demolition of the workshop it is recommended that further investigation is undertaken to confirm the nature of the fill material and the depth.

Soakaways

9.29 The disposal of surface water using soakaways is unlikely to be practical on the site due significant sloping ground and the likely proposed retaining walls within the final development.

Retaining Structures

9.30 Due to the significant level differences on site several retaining structures will be required to accommodate the level variations between individual plots. Existing retaining walls are present along the northern boundary and along the southern boundary. Highways approval is likely to be required if any modifications are to be undertaken for the retaining wall along the southern boundary. A structural survey of the walls to be retained is advisable.

Services

9.31 Services utility maps were obtained on behalf of the client. The maps are presented within Appendix G.

Other Constraints

9.32 The suspected well in the northwest corner of the site is likely to require backfilling in accordance with Environment Agency guidance. However, if the feature is confirmed to be a stone cattle trough fed by pipe or spring, then the structure should be excavated, replaced with suitable compacted material, and drainage measures provided to avoid any adverse impact from flowing water.

9.33 For any excavations in close proximity to the site boundaries, the requirements of The Party Wall Act 1996 will need to be observed.

A P P E N D I X A

SITE LOCATION PLAN, AERIAL PHOTOGRAPH AND INDICATIVE PROPOSED LAYOUT

Project **106 GREENFIELD ROAD, HOLMFIRTH**	Title **SITE LOCATION PLAN**	ARP GEOTECHNICAL LTD CHARTERED CONSULTING ENGINEERS	Date **DECEMBER 18**	Scale **AS SHOWN**
Client **HH SERVICES LTD**			Drawn **@ A3**	Job No. **HSV/01**
			Rev.	

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Project **106 GREENFIELD ROAD, HOLMFIRTH**	Title **AERIAL PHOTOGRAPH**	ARP GEOTECHNICAL LTD CHARTERED CONSULTING ENGINEERS	Date **DECEMBER 18**	Scale **AS SHOWN**
Client HH SERVICES LTD			Drawn **@ A3**	Job No. **HSV/01**
			Rev.	

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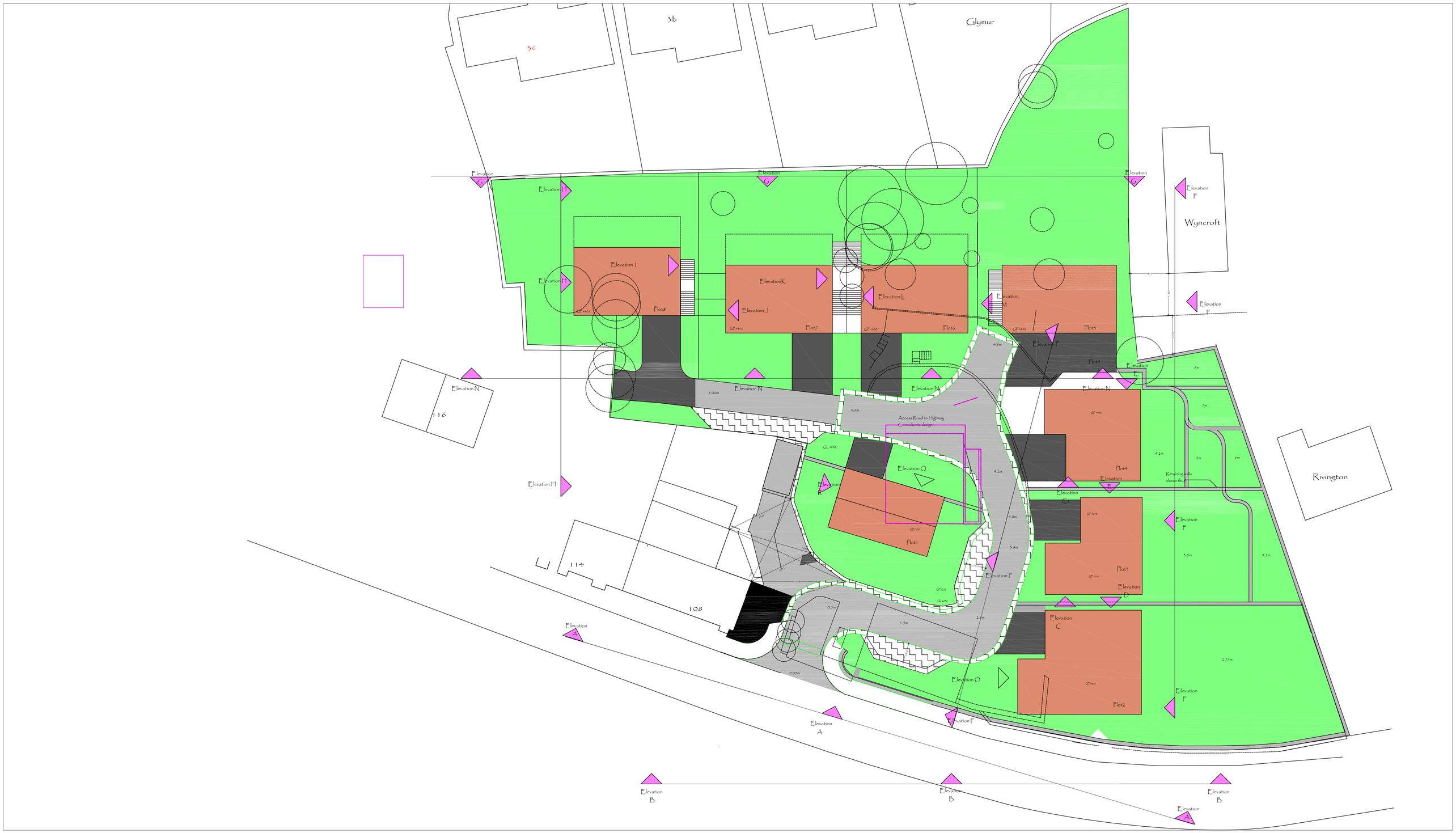
3c
3b
Glymur
Wyncroft
Rivington
116
114
108
Elevation G
Elevation H
Elevation I
Elevation J
Elevation K
Elevation L
Elevation M
Elevation N
Elevation O
Elevation P
Elevation Q
Elevation A
Elevation B
Elevation C
Elevation D
Elevation E
Elevation F
Plot1
Plot2
Plot3
Plot4
Plot5
Plot6
Plot7
Plot8
Access Road to Highway
Constructed design
Retaining walls shown thus
GF+100
GF+200
GF+300
GF+400
GF+500
GF+600
GL+600
GL+700
GL+800
GL+900
4.8m
4.2m
4.0m
3.8m
3.5m
4.5m
2.75m
2.5m
1.5m
0.5m
0.00m
5.00m
4.9m
8m
7m
6m
5m

APPENDIX B

SITE WALKOVER PHOTOGRAPHS