COMBINED STAGE 1/STAGE 2

GEO-ENVIRONMENTAL REPORT

AT

THONGSBRIDGE MILLS

THONGSBRIDGE

ON BEHALF OF

MR S MARSDEN

ARP GEOTECHNICAL LTD

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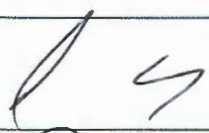
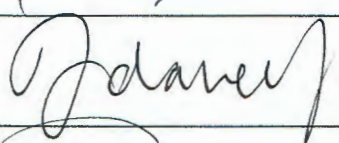
Prepared By:	A Jones BSc FGS	
Reviewed By:	J Davey BSc(Hon) PhD RPGeo	
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1.0 EXECUTIVE SUMMARY

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	Multi-use commercial units
Existing Site Description	Occupied by open rough ground. Site is mostly flat but slopes steeply at its western boundary up to Huddersfield Road. Occasional trees around boundaries.
Site History	Mill pond from 1854, presumably infilled sometime between 1987 and 1995. Remainder of site undeveloped.
Geology	River terrace deposits over southeast of the site. Bedrock is sandstone (Huddersfield White Rock) and mudstone/siltstone (Marsden Formation). No faults recorded on/near site.
Coal Mining	Site can be considered stable.
Hydrology	Nearest watercourse is River Holme, 15m to east. No sensitive abstractions within 1km of site. Vast majority of site not at risk of river flooding but southern corner in flood zone 2 and 3.
Landfill Gas	Gas protection measures required for carbon dioxide and methane.
Ground Conditions	Up to 4.6m of made ground, overlying very soft to firm alluvial clay and silt, with bedrock at depths of between 0.0m and 5.0m.
Contamination	Elevated PAH, asbestos (<0.001%).
Remediation Strategy	0.45m thick cohesive clean cover in any landscaping areas and liaison with water authority regarding water pipes.
Foundations	<u>Unit A to C (Unit in west)</u> Partly piled and partly strip/trench/mass fill foundations or deep excavations and mass engineered fill platform with raft. <u>Unit D to F (Unit in northeast)</u> Piled foundations recommended. May be possible for the northern end of the unit to utilise deep trench/mass fill footings. Specialist advice is required.

Excavations	Liable to collapse in areas of deep made ground. Excavation of bedrock is likely to be required, especially close to the western boundary of the site. Groundwater should be controllable by pumping from a sump.
Concrete	FND 3z designation for unreinforced foundations in natural strata, and FND4z with additional protection in made ground. For any reinforced concrete, other design-specific mixes will apply.
Additional	A sluice is located on site. The extent of this under the site is not known. Care will need to be taken when excavating. Requirements of Party Wall Act should be observed.
Soakaways	The use of soakaway drainage on this site is not considered feasible on the site, due to the ground conditions encountered.

2.0 TERMS OF REFERENCE

2.1 Mr S Marsden is considering developing the site at Thongsbridge Mills with multi-use commercial units. It was considered appropriate to provide information to aid viability assessment and design of any subsequent development. In August 2005, ARP Geotechnical Ltd issued a Geo-Environmental Risk Report (Reference MSD/01). This involved a desk study assessment of the geological and coal mining aspects, Ordnance Survey archive plans search, environmental search, radon gas appraisal and indicative flood risk, together with an intrusive ground investigation by excavating trial pits on the site to assess the subsoil conditions. In order to identify the severity and extent of any contamination, and allow any potential remedial strategy to be identified, the report also included a Contamination Risk Assessment. Due to the period of time elapsed since this report was issued, and to target areas previously not investigated, it was deemed necessary to carry out further investigation and sampling, in accordance with current guidance.

2.2 In August 2018, ARP Geotechnical Ltd was appointed by Mr S Marsden to carry out the further investigation, which involved a desk study assessment of the geological and coal mining aspects, Ordnance Survey archive maps, radon gas, indicative flood risk, hydrogeology, landfill, and other environmental issues, primarily by assessment of a Landmark Envirocheck Report and an intrusive investigation 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 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.

2.5 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.

2.6 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 SITE DESCRIPTION

Site Location

3.1 The site, which is centred on Ordnance Survey Grid Reference 414710, 409650, is located on the east side of Huddersfield Road, in Thongsbridge, near Huddersfield. The site is approximately 0.95 hectares in size, with overall dimensions of 160m (northeast - southwest) by 65m (east - west).

3.2 A site location plan and aerial photograph are presented in Appendix A.

3.3 The vast majority of the site is relatively flat and level. However, the western margin of the site slopes steeply upwards to meet Huddersfield Road. A number of cuts have been made into the slope and retaining walls constructed. In the far south of the site, in the western margins of the site, a large retaining structure exists in a low area/hollow, possibly used for storage of crushed rock. Also, within the western margin of the site is a retaining wall structure with a beam and block suspended floor. Again, this appears to be in use as a storage area - two IBC containers were located on the suspended floor. The structure may be the beginnings of a house or other building, which has been halted. In the far south of the site, a relatively new access road, complete with drainage, has been built.

3.4 Machinery/plant is stored in the far northern corner of the site and two stockpiles of crushed stone are present in the northeastern corner. Another large stockpile of crushed stone is present in the south of the site, adjacent to the large retaining structure located in the low area/hollow. Natural sandstone outcrops are adjacent to the road, near the retaining structure. Vegetated ground cover is typically rough grass or young shrub/weed vegetation.

Site Boundaries and Surrounding Land Use

3.5 The site is bounded to the north by an industrial estate. A retaining wall approximately 3m high forms the boundary between the site and this estate. The site is on the high side of the retaining wall. The site is bounded to the east by a row of mature trees, a small masonry retaining wall (low side to the east), a storage area for plant/machinery, and then rough ground sloping downwards until the River Holme. The site is bounded to the south by mature trees and then a large industrial/farm building. The site is bounded to the west by Huddersfield Road, houses and fields beyond.

3.6 A recently built (2010) split-level house is present immediately to the western boundary of the site. The house has been built into the side of Huddersfield Road, such that the front entrance is at level with Huddersfield Road and the rear of the house is level with the site. The rear of the house looks over the site. Another house exists at the western boundary but is higher (approx. 2m) than the site. This house also looks out directly over the site.

3.7 There is a sluice structure in the northeastern corner of the site. The feature was dry at the time of the walkover, and does not show any evidence of recent use. The extent of the sluice structure underneath the site was not clear.

Site History

3.8 Ordnance Survey archive maps were obtained for the site. Copies of the maps are included in Appendix C, and a summary of the findings is given below.

Map Date	On-Site	Off-Site
1854	The plan is indistinct, but shows a possible water body on the site.	A Woollen Mill is indicated just beyond the northeastern corner of the site. A road runs along the western boundary.
1893	Most of the site is occupied by a mill pond for the adjacent woollen mill. The remainder of the site is shown to be undeveloped.	Huddersfield Road forms part of the western boundary, and a residential property the remainder. A Woollen Mill building is shown immediately beyond the northeast of the site.
1906	The Mill Dam appears to be formed by an embankment on the southeastern side.	No significant change.
1974	No significant change.	Electricity sub-station close to northern corner of site.
1987	No significant change.	Mill building adjacent to the northeast has been removed, except for a small section.
1995	The on-site mill pond is no longer shown, presumably infilled.	Small new buildings are now present adjacent to the northeast, in the former location of the woollen mill.
Later Maps	No significant change.	No significant change.

3.9 In summary, the site was occupied by a large mill pond from at least 1854 until sometime between 1987 and 1995, when it was presumably infilled. The remainder of the site has remained undeveloped. The surrounding land has been occupied by woollen mills and residential properties.

4.0 ENVIRONMENTAL SETTING

Geology

4.1 Extracts from the British Geological Survey 1:50,000 Series Geology Maps are included within the Envirocheck Geology Report in Appendix D. The maps show that the south and east of the site is covered by superficial deposits comprising river terrace deposits (sand and gravel). Bedrock across the site consists of Huddersfield White Rock (sandstone) across the northern two thirds of the site and Marsden Formation (mudstone and siltstone) across the southern third.

4.2 The geology maps do not indicate any potential for the site to be adversely affected by any faults.

Coal Mining

4.3 A Consultants Coal Mining Report was obtained from The Coal Authority. A copy of the report is included in Appendix E, and a summary is given below.

4.4 The site is not affected by any past, present, or future proposed underground coal mining.

4.5 There are no recorded mine entries on or within 100m of the site.

4.6 The site is unaffected by any past, present, or future proposed, opencast coal mining.

4.7 In view of the above, the site is considered stable with regard to coal mining.

Coal Recovery

4.8 There are no known workable seams beneath the site. There will be no arisings of coal during proposed development works, and it will not be possible to win any coal from the site before development.

Hydrogeology

4.9 The Landmark Envirocheck Report, included in Appendix F, indicates both the Bedrock and superficial Aquifer Designations to be 'Secondary A' aquifer. These aquifers comprise "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers".

4.10 There are no groundwater abstractions within 1km of the site.

4.11 The site is not within a groundwater Source Protection Zone.

Hydrology

4.12 The general area slopes down to the east. The nearest downslope surface water is the River Holme, 15m beyond the eastern corner of the site. Any surface water run-off from the site is likely to quickly enter the river.

4.13 The vast majority of the site is not in an area at risk from river flooding, with the exception being a small area in the southern corner of the site, which is within Flood Zones 2 and 3. BGS data indicates the general area has the "potential for groundwater flooding to occur at the surface" and "of property situated below ground level" (i.e. basements or similar). The risks of flooding from other causes such as adverse topography or insufficient surface water drainage, are not considered here, and a separate specialist Flood Risk and Drainage Report should be commissioned if such risk needs to be quantified.

4.14 There are two surface water abstractions within 1km of the site, at approximately 405m and 504m to the northeast for power generation and general industrial use respectively. Neither of these are considered sensitive abstractions.

Other Environmental Data

4.15 The Landmark Envirocheck Report, included in Appendix F, contains information on numerous environmental aspects. A summary of the pertinent findings, not already covered, with additional comments, is given below.

4.15.1 There are no active Pollution Control Authorisations within 200m of the site.

4.15.2 There are no discharge consents relating to, or adjacent to, the site. There are a number of consents upstream of the site, for discharge of sewage effluent.

4.15.3 There is one recorded landfill within 250m of the site, located 176m to the southeast. This is listed as having waste including industrial, commercial and household waste.

4.15.4 No radon protective measures are stated to be necessary for new dwellings on the site. However, the site is in an intermediate probability radon area, as between 1% and 3% of homes are estimated to be above the radon action level. In these circumstances of apparent conflict, it may be prudent to assume basic radon protection is required, to prevent conveyancing difficulties.

4.15.5 There are no contemporary trade directory entries relating to any activities which could have significant impact on the site.

4.15.6 There are no fuel station entries within 200m of the site.

5.0 PRELIMINARY RISK ASSESSMENT AND CONCEPTUAL MODEL

5.1 Part II A of the Environmental Protection Act (EPA) 1990 became effective from 1st April 2000. The Regime was introduced by the Contaminated Land (England) Regulations 2000 (SI 2000, No. 227) along with the associated DEFRA Circular February 2000.

5.2 Section 78A (2) of the Act defines "Contaminated land is any land ……. in such a condition, by reason of substances in, on or under that land that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused".

From S78A (4) "Harm" : means harm to the health of living organisms or other interference with the ecological systems of which they form part and, in the case of man, includes harm to his property.

Controlled waters are defined as "..the waters in any relevant lake or pond, or of so much of any relevant river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata". From the 1st October 2004, the definition of groundwater in relation to Part IIA was amended, by the Second Water Act Commencement Order SI 2004 No 2528. This makes clear that "ground waters" does not include waters above the saturation zone, i.e. does not include any soil water and pore water present in the unsaturated zone.

5.3 The objectives of the regime are to ensure that risks associated with contaminated land are reduced to an acceptable level, having regard to the costs of doing so. The costs should be proportionate, manageable and economically sustainable.

5.4 In assessing risk, it is necessary to consider the probability, or frequency, of occurrence of the hazard and the magnitude/seriousness of the consequences. Consequently, for land to be classified as contaminated, it must have, or be very likely to have, a detrimental effect on humans or the environment before it can be classified as contaminated land.

5.5 In establishing risk, the concept of the pollutant source/pathway/receptor linkage model, based on current and proposed site use, is to be considered. Therefore for a site to be deemed contaminated under the Regime, all three linkages must be in place i.e. the site must not only contain harmful substances, but the substances must have a pathway by which to leak out and cause significant harm to a receptor.

5.6 In September 2004, the Environment Agency published the Contaminated Land Report (CLR) 11, "Model Procedures for the Management of Land Contamination". The document is intended to provide the technical framework for structured decision making about land contamination, and is intended to assist all those involved in "managing" the land, in particular landowners, developers, financial service providers, planners and regulators. As the document currently provides the framework for best practice, the general principles are, therefore, followed in conducting the assessment below.

5.7 The categorisations of risk adopted in this report are adapted from CIRIA Report C552 (Contaminated Land Risk Assessment: A Guide to Good Practice, 2001). This approach assesses the potential severity of any pollution event and the probability of the event occurring, to arrive at a risk category, for the various potential source - pathway - receptor linkages. The relevant tables used, with the definitions, are presented in Appendix G.

Conceptual Site Model

5.8 It is known that the site is proposed for multi-use commercial units, with associated hardstanding and minimal landscaping. An indicative proposed site layout is included in Appendix H. The southeastern half of the site is shown to be underlain by river terrace sands and gravels, overlying sandstone on the northern two thirds of the site and

mudstone/siltstone on the southern third. The solid strata beneath the site are designated a 'Secondary A' aquifer. There are no groundwater abstractions within 1km of the site. The nearest surface water is the River Holme approximately 15m to the east. There are no sensitive surface water abstractions within 1km of the site.

5.9 The site was occupied by a large mill pond from at least 1854 until sometime between 1987 and 1995, when it was presumably infilled. The remainder of the site has remained undeveloped. More recently, some retaining structures have been constructed on the site, possibly as part of an aborted residential development. The most likely contamination sources are considered to be:

5.9.1 Probable made ground (recent infill to former mill pond and original made ground from mill development): – metals inorganics, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAH), phenol, asbestos.

5.9.2 Possible contamination from the adjacent old mill: - pH, benzene, toluene, ethylbenzene.

5.9.3 Landfill site 176m to the southeast, and possible mill-pond silt: - methane and carbon dioxide.

5.10 The conceptual model needs to consider sources of contamination, pathways along which contaminants could migrate and the receptors, which may become exposed. Guidance published by the Environment Agency has been consulted with regard to pathways and receptors. The potential sources, pathways, and receptors, applicable to the proposed development are identified on the table below. Any pathways in italics are deemed not to be viable, and the reason given.

Potential Source - Pathway - Receptor Matrix (Finished Development)

Contamination Sources	Pathways	Receptors	Severity of Consequence	Probability of Event	Risk
Probable made ground (recent infill to former mill pond and original made ground from mill development): – metals inorganics, TPH, PAH, phenol Possible contamination from use of adjacent land as a mill: -, pH, benzene, toluene, ethylbenzene	• Inhalation, ingestion and dermal contact with soil and dust • *Fruit and vegetable intake, with soil (not applicable)* • Vapour inhalation outdoor • Vapour inhalation indoor	**Humans:-** • Future site users • Maintenance workers • Adjacent residents and general public	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• Migration in surface water	• Surface water (nearest downslope is 15m to east). There are no sensitive abstractions within 1km	**Medium**	**Unlikely**	**Low**
	• Migration in groundwater	• Groundwater (Secondary A Aquifer, no abstractions within 1km)	**Medium**	**Unlikely**	**Low**
	• Root uptake	**Vegetation:-** • Landscape areas	**Medium**	**Low Likelihood**	**Moderate/ Low**
	• Migration	**Services/Utilities:-** • Potable water supply	**Medium**	**Low Likelihood**	**Moderate/ Low**
Landfill 176m to southeast, possible pond silt:- methane and carbon dioxide	• Asphyxiation • Explosive risk	• Construction/de-molition workers • Future site users • Buildings	**Severe**	**Low Likelihood**	**Moderate**
Possible asbestos within made ground	• Inhalation	• Future site users • Maintenance workers • Adjacent residents and general public	**Severe**	**Low Likelihood**	**Moderate**

5.11 The above matrix indicates there are several potential source – pathway – receptor linkages applicable to the proposed development, ranging from moderate to low risk.

5.12 The assessment was used to inform the design of the subsequent ground investigation. To fully characterise the site, in accordance with BS10175 : 2011 + A2 : 2017 "Investigation of potentially contaminated sites - Code of practice", and to address the above concerns, it

was decided that, in addition to geotechnical information required, the site investigation should include:

5.12.1 Sampling on a grid basis, preferably 25m spacing, by means of trial pits and windowless sample boreholes.

5.12.2 Samples of the made ground issued for testing for a broad suite of determinands, including metals, inorganics, asbestos, phenols, speciated PAH, and TPH.

5.12.3 Ground gas monitoring due to the presence of a landfill 176m to the southeast and possible mill pond silt on-site.

5.12.4 Upon receipt of contamination test results, any elevated TPH would be speciated to allow further risk assessment, and leachability testing undertaken on all elevated determinands, to give indication of mobility.

6.0 SITE INVESTIGATIONS

6.1 On 28th July 2005, ARP carried out a trial pit investigation on the site (for the same client), but also including a larger area to the south and west. The trial pits were carried out on an approximate 25m grid. The trial pits relevant to the new site boundary are A3, A4, A5, B4, B5, and B6. The trial pits were taken to depths of between 0.5m and 3.3m.

6.2 On the 10th of August 2018, a further ground investigation was carried out. The purpose of this investigation was to confirm the current status of the site, given the elapsed time of over ten years, and to allow monitoring of gas wells, as for the original report, only a gas spike survey was carried out. The report 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.

6.3 Six windowless sample boreholes (WS1 to WS6) were implemented on the grid, to satisfy the requirements of the British Standard, along with targeted hand sampling of two locations from each of two stockpiles on site (sample numbers 1 and 2 from stockpile numbers 1 and 2). The boreholes were taken to depths of between 0.9m and 5.3m.

6.4 Both the 2005 and 2018 investigations were organised, supervised and logged by an Engineer from ARP Geotechnical Ltd.

6.5 Three gas monitoring wells were installed, in WS2, WS4 and WS6, and subsequently monitored by ARP Geotechnical Ltd. The wells in WS2 and WS4 were installed to 3m depth, and to 1m depth in WS6, which terminated at shallow depth in sandstone. The upper 1m (0.5m in WS6) comprised plain pipe with bentonite seal and lockable flush cover, and the lower section comprised slotted pipe with gravel surround.

6.6 Justifications for the sampling locations are provided on the table below.

LOCATION	REASON
A3, A4, A5, B4, B5, and B6	2005 locations – part of a general grid and relevant to the new site boundary
WS1-WS6	Part of a general grid
Sample 1 & sample 2	Stockpile testing

6.7 The trial pit and borehole logs are included in Appendix J, along with the location plan. It should be noted that any 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.

6.8 Chemical analysis of five soil samples from the 2005 investigation were tested for a broad suite, including metals, inorganics, PAH, TPH, phenols, BTEX and asbestos screen, by ECOS Environmental in Bradford. The test certificates are included in Appendix K. It should be noted that samples blanked out relate to areas on the larger site, which no longer fall within the current site boundary.

6.9 From the 2018 investigation a total of fifteen samples were tested for the ARP Geotechnical Limited standard suite (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) by the UKAS accredited Concept Life Sciences Laboratory in Manchester. Elevated determinands were tested further for leachability to determine the potential mobility of the contaminants. The test certificates are included in Appendix K.

6.10 Analysis for Atterberg Limits, moisture content, pH and water soluble sulphate was undertaken by the UKAS accredited Professional Soils Laboratory (PSL) in Doncaster. The test certificates are included in Appendix K.

7.0 SUMMARY OF GROUND CONDITIONS

Strata and Groundwater

7.1 Made ground was encountered across the majority of the site, to depths of typically between 1.5m and 2.6m. In WS4, near the centre of the site, made ground was encountered to a depth of 4.6m. Made ground was locally absent in positions A5, B5 and B6 in the north of the site. The made ground encountered typically comprised gravel, cobbles and boulders of sandstone in a clayey, sandy matrix. Soft sandy clays, with variable granular content, were also present, usually below the granular material. Occasionally, the made ground contained fragments of brick, wood, concrete and glass. Locally, the made ground consisted of reworked natural clay and silt.

7.2 Below the made ground, alluvium, comprising very soft to firm grey, sandy slightly gravelly silty clay, occasionally grading to sandy silt, was encountered. This was locally absent where bedrock was found at very shallow depth, and in position WS4 where the deepest made ground was encountered. A dark-grey silty stratum was found within this unit in WS1 and WS2.

7.3 Bedrock was encountered at depths of between 0.0m (at surface) and 5.0m, as weak sandstone and locally as a very weak mudstone. Over the majority of the site, the bedrock was encountered beneath the alluvial deposits described above. Shallow bedrock was encountered in positions A5, WS5 and WS6 which are all close to the western boundary where the site rises up and meets Huddersfield Road.

7.4 The excavations within the trial pits generally remained stable for the short period of exposure, and the pits were backfilled with the arisings on completion. No groundwater ingress was encountered during either of the two investigations, although both were carried out in the summer months. Subsequent monitoring of the boreholes identified a very small amount of water to be present at the base of the monitoring installations but this is not considered to be representative of a continuous groundwater table.

Gas Assessment

7.5 The ground gas investigation was undertaken in accordance with BS 8576 : 2013 "Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)". Ground gas risk assessment was carried out in accordance with BS 8485 : 2015 "Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings".

7.6 The monitoring carried out on four occasions over a nine week period, showed a maximum methane (CH_4) concentration of 10.3% v/v, a maximum carbon dioxide (CO_2) concentration of 9.8% v/v, and zero flow rate. The number of gas monitoring rounds carried out is considered appropriate for the proposed development and, therefore, no further gas monitoring is proposed. The gas monitoring results are presented in Appendix L.

7.7 The British Standard, BS 8485 : 2015, utilises the concept of borehole hazardous gas flow rates (Q_{hg}), in litres/hour (l/hr), which are obtained by multiplying flow rate by concentrations in the air stream of the particular gas being considered for each borehole. The Q_{hg} is used to derive a gas screening value (GSV), which is defined as the "flow rate of a specific hazardous gas representative of a site or zone, derived from assessment of borehole concentration and flow rate measurements and taking account of all other influencing factors, in accordance with a conceptual site model".

7.8 The table below allows the selection of the 'Characteristic Situation' (CS) based on the GSV, using a numbering system of 1 to 6, where 1 equates to a very low hazard potential and 6 equates to a very high hazard potential. For reference, the equivalent NHBC Traffic Light categories are also provided (from "Guidance On Evaluation Of Development Proposals On Sites Where Methane And Carbon Dioxide Are Present", NHBC Report No. 4, 2007).

Characteristic Gas Situation (CS)	Hazard Potential	Gas Screening Value - l/hr - (GSV)	Additional Factors
1	Very Low	<0.07	Typically <1% CH_4 and <5% CO_2, otherwise consider an increased Characteristic Gas Regime
2	Low	>0.07 to <0.7	Typical Measured Flow Rate <70l/hr, otherwise consider an increase to CS 3
3	Moderate	>0.7 to <3.5	
4	Moderate to high	>3.5 to <15	
5	High	>15 to <70	
6	Very High	>70	

Based on Table 2 of BS 8485:2015

7.9 A summary of the results obtained from the ground gas monitoring investigation, together with calculated Q_{hg}s for methane and carbon dioxide, is presented in the table below.

Borehole Reference	Max Recorded Steady Flow (l/hr)	Max. CO_2 (% v/v)	Max CH_4 (% v/v)	Max BH Qhg (CO_2)	Max BH Qhg (CH_4)
WS2	0.1	4.80	0.0	0.0048	0.0000
WS4	0.1	9.8	10.3	0.0098	0.0103
WS6	0.1	4.6	0.0	0.0046	0.0000
			Worst-credible Qhg (l/hr) *	0.0098	0.0103
			Worst-possible Qhg (l/hr) +	0.0098	0.0103

* Based on maximum recorded concentration and maximum flow rate applicable to any individual borehole.

+ Based on maximum recorded concentration and maximum flow rate across the whole site (any borehole)

7.10 The worst credible gas regime identified on the site (based on the maximum recorded flow rate and concentration detected together within an individual borehole) is a Q_{hg} of 0.0098l/hr for carbon dioxide and 0.0103l/hr for methane. The maximum concentration of carbon dioxide is 9.8% and the maximum concentration of methane is 10.3%. This equates to a Characteristic Gas Situation of 1. However, the table states that an increased Characteristic Gas Situation (CS) should be considered due to the carbon dioxide, when above a concentration of above 5%, and methane when above a concentration of 1%. As both methane and carbon dioxide are significantly above these levels, a CS of 2 is applicable. Low level gas protection measures are, therefore, required for the proposed buildings.

7.11 It is also a requirement of the British Standard to check the very worst case combination of the highest flow and the highest detected concentrations, of any borehole, with values not necessarily from the same borehole. If the worst case conditions indicate a higher hazard could reasonably exist, then this should be adopted as the GSV, unless further monitoring or other justification is provided for it not to be used. In this case, the worst possible case is the same as the worst credible case and therefore a CS of 2 still applies.

8.0 CONTAMINATION ASSESSMENT

Screening Values - Soils

8.1 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.

8.2 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%.

8.3 A table showing the screening values utilised is included in Appendix K.

Screening Values - Leachability and Groundwater

8.4 In order of preference, the Environmental Quality Standards (EQS) annual averages for freshwater have been used as generic screening values for these results. Where no EQS is available, the stringent UK Drinking Water Standards (DWS) have been used, and other sources in the absence of EQS and DWS, as indicated on the groundwater screening values table in Appendix K.

Soils Analysis

8.5 In total, twenty soil samples were tested in total for both investigations, for a 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). In addition, the samples of 2005 were tested for BTEX (benzene, toluene, ethybenzene and xylene. The testing comprised:

Fourteen samples of made ground from TPA3, TPA4, TPB4 and WS1 to WS6
Four samples of stockpiled crushed stone from stockpiles 1 and 2
Two samples of natural ground from trial pits B5 and B6

Made Ground

8.6 The majority of the results on the made ground were found to be below the relevant screening values. However, WS2 contained loose chrysotile fibres at 1.0m to 1.2m depth (although not in the sample above, from 0.5m to 0.7m depth). In addition, WS6, at 0.3m to 0.5m depth, contained amosite fibres, and dibenzo(ah)anthracene at 17 mg/kg (the assessment criteria is 3.6 mg/kg). At positon A4, a total PAH of 43.1 mg/kg was identified. This is slightly raised and could be elevated for one of the individual PAH determinands. This was not speciated (to give individual determinands) as the testing was undertaken in 2005 and this testing was not typically implemented at this time.

8.7 Further asbestos quantification was carried out on the two samples mentioned above and both samples were identified to have <0.001% asbestos. The elevated/raised dibenzo(ah)anthracene and PAH result however must be taken into consideration. This determinand has minimal vapour migration potential.

Crushed Stone (Stockpiles 1 and 2)

8.8 Testing on the crushed stone identified all the determinands to be below screening values. The material is even below the more conservative screening values applicable to residential use. Therefore, if required, this material is suitable to be retained/used on site, in terms of human health risks.

Natural Ground

8.9 In natural strata, the testing identified all the determinands to be below screening values (even when assessed against more conservative screening values for a residential end use). Total TPH is raised within trial pit B6, but this is considered to be representative of the natural high organic content in this sample.

Water/Leachability Analysis

8.10 Position WS6 at 0.3m to 0.5m identified dibenzo(ah)anthracene at 17mg/kg. A leachability analysis for speciated PAH was undertaken on this sample. The leachability result is presented in Appendix K. The results show the sample to have a slight degree of leachability, with results ranging from <0.01 µg/l to 0.26µg/l obtained. However, given the limited source volume and that the vast majority of the site surface will be impermeable (buildings and hardstanding, with limited small areas of landscaping), then the leachability of the PAH at this one location does not warrant any specific remedial measures.

Updated Risk Assessment and Conceptual Model

8.11 The updated source – pathway – receptor matrix is presented below, taking into account the findings of the investigation. Any pathways in italics are deemed not to be viable, and the reason given.

Viable Source - Pathway - Receptor Matrix (Finished Development)

Contamination Sources	Pathways	Receptors	Severity of Consequence	Probability of Event	Risk
Made ground (recent infill to former mill pond and original made ground from mill development): – dibenzo(ah)anthracene at 17 mg/kg	• Inhalation, ingestion and dermal contact with soil and dust • *Vapour inhalation outdoor (not applicable to the contaminants present)* • *Vapour inhalation indoor (not applicable to the contaminants present)*	**Humans:-** • Future site users • Maintenance workers • Adjacent residents and general public	**Medium**	**Low**	**Moderate/ Low**
	• *Migration in surface water (minimal source volume and minimal soft areas)*	• Surface water (nearest downslope is 15m to east). There are no sensitive abstractions within 1km	**Negligible**		
	• *Migration in groundwater (minimal source volume and only slight leachability)*	• Groundwater (Secondary A Aquifer, no abstractions within 1km)	**Negligible**		
	• Root uptake	**Vegetation:-** • Landscape areas	**Medium**	**Low**	**Moderate/ Low**
	• Migration	**Services/Utilities:-** • Potable water supply	**Medium**	**Low**	**Moderate/ Low**
Landfill 176m to southeast, and pond silt on site:- methane and carbon dioxide	• Asphyxiation • Explosive risk	• Construction/de-molition workers • Future site users • Buildings	**Severe**	**Low**	**Moderate**
Asbestos within made ground (<0.001%)	• Inhalation	• Future site users • Maintenance workers • Adjacent residents and general public	**Severe**	**Low**	**Moderate**

8.12 It can be seen from the above matrix that several pathways to receptors are operative, with moderate risk applicable and this may affect users of the finished development. Some form of remedial action is, therefore, considered necessary to allow development without excess risk.

Risk Based Assessment of Remedial Options

Landfill/Ground Gases

8.13 To address the potential risk from landfill/ground gases, monitoring of borehole wells has been completed. The monitoring has confirmed that protection of proposed buildings against carbon dioxide and methane ingress is required.

Made Ground - Ingestion, Dust Inhalation, Dermal Contact and Root Uptake

8.14 This pathway is automatically blocked where buildings or hardstanding are present above the material. In any localised landscaping areas/features it is recommended that at least 0.45m of clean topsoil/subsoil is placed above any made ground.

Migration to Utilities

8.15 Any migration to utilities is unlikely to be significant. However, the local water company are likely to require details of the contaminants present on the site, to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress.

Risks During Construction Period

8.16 It is also necessary to consider the effects of the contamination present on the site in relation to the risks to adjacent residents, construction workers and the general public during construction. This is assessed in the following matrix.

Source	Pathway	Potential Risk	Risk after employing suitable Health and Safety plan.
Existing made ground (including <0.001% asbestos)	Inhalation	Moderate	Damping down of the site during dry periods and timely placement of the existing made ground below barriers should block this pathway and reduce the risk to negligible.
Existing made ground (including <0.001% asbestos)	Ingestion	Moderate	Site fencing will exclude access to members of the public. Existing made ground will be contained within the site boundary, and placed below barriers as soon as possible. Washing facilities and a clean mess room from which work boots and overalls are excluded should be provided. These measures should block this pathway and reduce the risk to negligible.
Existing made ground (including <0.001% asbestos)	Contact	Moderate	Education of workers to use adequate hygiene and PPE should block this pathway and reduce the risk to negligible.
Existing made ground (including <0.001% asbestos)	Surface water	Moderate	Preventing surface water run off by minimising open exposure times of the existing made ground, and using bunds or cut off trenches as necessary should block this pathway and reduce the risk to negligible.

8.17 Provision of all the above measures will ensure that all the identified pathways for the contamination will be blocked.

Summary of Contamination Identified and Remedial Options

8.18 The site is underlain by up to 4.6m thickness of made ground, overlying alluvial deposits, of very soft to firm clays and silts, and then bedrock. In the north of the site, made ground is absent and bedrock either outcrops or is underlying shallow residual soils. Monitoring of ground gases, by means of borehole well installations, has been completed, and shows that the proposed buildings will require protection against methane and carbon dioxide ingress.

8.19 The made ground was found to contain localised elevated concentrations of dibenzo(ah)anthracene, and trace amounts of asbestos (less than 0.001%).

8.20 The contamination risk assessment, and assessment of remedial options, has indicated that, provided that the following remedial measures are adopted then the risks to the identified receptors are deemed acceptable for the proposed development of commercial units with access road and service yard.

8.20.1 Where localised areas of landscaping are present, at least 0.45m thickness of uncontaminated soil should be provided.

8.20.2 Any imported soils used within landscaped areas 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".

8.20.3 Gas protection is required. CS2 classification requires a gas protection score of 3.5. There are a number of ways to achieve this, including the use of underfloor ventilation, gas barriers, and various floor constructions. The specific design of the protection measures, and the verification required, is dependent on the detailed foundation design, the selection of products/suppliers, the gas regime, and who installs the protection. Once more of these factors are known, as a minimum following foundation design and design of the protection measures, a Method Statement for Gas Protection should be prepared for the regulators and contractors.

8.21 The local water company are likely to require details of the contaminants present on the site, to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress

8.22 A Contamination Remediation Statement is included in Appendix M.

9.0 GEOTECHNICAL TESTING

9.1 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 K and a summary of the results, including Modified Plasticity Indices, is given below.

Location	Depth (m)	MC	LL	PL	PI	% <425µm	I'p
WS1	2.5-2.7	33	54	28	26	80	20.8
WS2	3.6-3.8	29	38	20	18	94	16.9
	No. of results	2	2	2	2	2	2
	Min.	29	38	20	18	80	16.9
	Max.	33	54	28	26	94	20.8

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

9.2 The plasticity test data shows the clay strata to be 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 20.8. In accordance with the Standard, this equates to Medium Volume Change Potential.

9.3 Geochemical testing (water soluble sulphate and pH) was undertaken on selected samples by Concept Life Sciences and DETS laboratories (sub-contracted by PSL), comprising four samples of natural strata and 14 samples of made ground. In accordance with the BRE

Special Digest 1 "Concrete in aggressive ground", the characteristic values for the two materials are given below:

Characteristic Values

Material	pH	SO_4
Made Ground	4.1	1550
Natural Strata	4.8	160

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

9.4 Testing conducted in 2018 indicated that in WS1 and WS2, made ground had a pH of 6.3 and 6.9 respectively. However, it is noted that across site and in the areas outside the current site boundary, made ground and natural strata consistently had low pH (below 5), with the lowest being 3.7 in made ground in B4, in the centre-southeast. Conversely, the made ground in A3 has returned a pH of 9.0 with total sulphates of 3,476mg/kg. The higher pH may be explained by volumes of crushed concrete noted at this site. The acidity in both the natural and made ground is attributed to organic content, notably a layer or potentially peaty black soil in the natural ground, often also present as reworked ground in the made ground.

9.5 The Aggressive Chemical Environment for Concrete (ACEC) class is AC-3z for the natural strata. However, testing on the made ground indicates class AC-5z. Therefore, the use of FND4z designated concrete with additional protective measures such as APM3 (surface protection) will be necessary for unreinforced buried concrete, in accordance with BS 8500-1:2006, if the existing made ground is to be retained. If the existing made ground was to be removed (which due to its depth is considered very unlikely), the ACEC class in natural strata is AC-3z and the use of FND3z designated concrete would be required for unreinforced buried concrete. For any reinforced buried concrete, other design-specific mixes will apply.

10.0 COMMENTS AND CONCLUSIONS

Site Description

10.1 At the time of the investigation, the site was occupied by rough ground and grass or young shrub/weed vegetation. At the western boundary, a number of cuts have been made into the slope and retaining walls constructed. In the far south of the site, in the western margins of the site, a large retaining structure exists in a low area/hollow, possibly used for storage of crushed rock. Also, within the western margin of the site is a retaining wall structure with a beam and block suspended floor. In the far south of the site, a relatively new access road, complete with drainage, has been built. Plant/machinery is stored in the far northwest of the site.

10.2 The site is bounded to the north by an industrial estate. A retaining wall approximately 3m high forms the boundary, with the industrial estate on the lower side. The site is bounded to the east by a row of mature trees, a small stone retaining wall (low side to the east), a storage area for plant/machinery, and then rough ground sloping downwards until the River Holme. The site is bounded to the south by mature trees and then a large industrial/farm building. The site is bounded to the west by Huddersfield Road, houses and fields beyond.

Site History

10.3 Ordnance Survey archive maps show that the site was occupied by a large mill pond from at least 1854 until sometime between 1987 and 1995, when it was presumably infilled. The remainder of the site has remained undeveloped. The surrounding land has been occupied by woollen mills and residential properties.

Geology

10.4 The geological map shows that the south and east of the site is covered by superficial deposits comprising river terrace deposits (sand and gravel). Bedrock across the site consists of Huddersfield White Rock (sandstone) across the northern two thirds of the site and Marsden Formation (mudstone and siltstone) across the southern third. There are no faults indicated with the potential to adversely affect the site.

Coal Mining and Coal Recovery

10.5 The coal mining report indicates the site is stable with regard to coal mining. There are no recorded mine entries on or within 100m of the site.

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

Environmental Data

10.7 The strata, both superficial and bedrock, beneath the site are classed as a Secondary A Aquifer. There are no groundwater abstractions within 1km of the site and the site is not within a Source Protection Zone.

10.8 The nearest downslope surface water is the River Holme, 15m beyond the eastern corner of the site. There are two surface water abstractions within 1km of the site, at approximately 405m and 504m to the northeast for power generation and general industrial use respectively.

10.9 There is one recorded landfill within 250m of the site, located 176m to the southeast, and there is deep made ground on site with some organic content. Gas monitoring has identified maximum carbon dioxide and methane concentrations of 9.8% and 10.3% respectively. Risk assessment indicates that low level gas protection against carbon

dioxide and methane is required, as CS2 conditions are indicated. A CS2 classification requires a gas protection score of 3.5, in accordance with BS 8485 : 2015. There are a number of ways to achieve this, including underfloor ventilated, gas barriers, and various floor constructions.

10.10 The specific design of the gas protection measures, and the verification required, is dependent on the detailed foundation design, the selection of products/suppliers, the gas regime, and who installs the protection. Once more of these factors are known (as a minimum following foundation design and design of the protection measures) a Statement on Gas Protection should be prepared. The document should provide information for the Client and other interested parties, such as the regulatory authorities, outlining how gas protection measures will be implemented and the installation verified as satisfactory. The document should be agreed, prior to implementation, with the relevant Regulatory Authorities.

10.11 The vast majority of the site is not in an area at risk from river flooding, with the exception being a small area in the southern corner of the site, which is within Flood Zones 2 and 3. It is recommended that a separate specialist Flood Risk and Drainage Report should be commissioned if such risk needs to be quantified, unless one is already available.

10.12 BGS data indicates the site has the "Potential for Groundwater Flooding to Occur at Surface."

Ground Conditions Encountered

10.13 The ground investigation identified made ground across the majority of the site. It was locally absent in positions A5, B5 and B6 in the north and northwest. T he made ground encountered typically comprised gravel, cobbles and boulders of sandstone in a clayey, sandy matrix. Soft sandy clays, with variable granular content, were also present, usually below the granular material. Occasionally, the made ground contained fragments of brick,

wood, concrete and glass. Locally, the made ground consisted of reworked natural clay and silt.

10.14 Below the made ground, alluvium comprising very soft, to firm, sandy slightly gravelly silty clay, occasionally grading to sandy silt. This was locally absent where bedrock was found at very shallow depth and in position WS4 where the deepest made ground was encountered.

10.15 Bedrock was encountered at depths of between 0.0m (at surface) and 5.0m, as weak sandstone and locally as a very weak mudstone. Over the majority of the site, the bedrock was encountered beneath the alluvial deposits described above. Shallow bedrock was encountered in positions A5 (outcropping), WS5 and WS6 (shallow bedrock under residual soils) which are all close to the western boundary where the site rises up and meets Huddersfield Road.

Contamination Assessment

10.16 The contamination testing identified the made ground to contain localised elevated concentrations of dibenzo(ah)anthracene, and trace amounts of asbestos (less than 0.001%).

10.17 The contamination risk assessment confirmed that, provided remedial measures are implemented, basically comprising protection of the proposed buildings against carbon dioxide and methane ingress, and 0.45m of clean, cohesive cover to be placed in areas of localised landscaping, then the materials present on the site are compatible with the proposed commercial usage. Further detail is provided in the Contamination Remediation Statement included in Appendix M.

10.18 This Report should be issued to the local water company for it to make a judgment on any requirement for protection of buried water supply pipes from chemical attack/ingress.

Foundations

Units Close to the Western Boundary (Unit A to Unit C)

10.19 Due to the depth of made ground and variability of strength of the clays and silts, it is recommended that the founding stratum for this development is bedrock or an engineered platform.

10.20 The bedrock varies in depth from surface at the western side of the proposed unit, to approximately 4.5m at the eastern side of the unit. At the western side of the proposed unit, a steep slope occurs, below which the sandstone bedrock is at/very close to the surface. This slope will require excavation to some extent to allow the construction of the new unit. There are two primary options for foundations on site:

10.20.1 Use of a composite foundation. That is, partly using piled foundations and partly using shallow traditional foundations. The piles will need to be designed by a specialist piling contractor. Some of the piles may require rock socketing to achieve a required minimum length of pile. It should be noted that the adjacent land to the west (around 5m away) is a public highway and at a higher level than the site. It will be prudent to take into account the pH of soils on site when considering piling options, as specific piles will be required to withstand the acidity on site.

10.20.2 Founding of the unit on a platform of deep mass engineered fill. For this to occur, an excavation into the site and side of the slope will be required. A level platform will then be built using compacted earth, following a specified method. A rafted foundation can then be used on the constructed platform. Retaining walls and slope stability, as well as the stability of the adjacent road will need to be considered if this option is to be followed.

10.21 It is understood, from conversations whilst on site, that the client was involved with the building of the house to the immediate north of this proposed unit (built/completed in 2010). It is understood that rock excavation was undertaken during construction of this plot and that the lower level foundations were not piled but were deep mass fill foundations.

Units in the Northeast (Unit D to Unit F)

10.22 The founding stratum for this unit will need to be bedrock, as above the bedrock is either deep made ground or soft alluvial deposits, or both. The bedrock varies in depth below existing ground level from 1.95m at the far northern end of the proposed unit to 5.0m at far southern end of the proposed unit.

10.23 Due to the above, it is recommended that the unit is founded using piled foundations. The piles will need to be designed by a specialist piling contractor. The piles at the far northern end of the unit are likely to require rock socketing to achieve a required minimum length of pile. It should be noted that the adjacent land to the north (less than 10m away) is at a lower level than the site (approximately 3-4m lower). It will be prudent to take into account the pH of soils on site when considering piling options, as specific piles will be required to withstand the acidity on site.

10.24 It may be feasible to utilise a foundation solution where the majority of the unit is piled and the far northern end of the unit utilises trench/mass fill footings. This will require specialist advice. However, deep mass engineered fill is unlikely to be viable on this side of the site, due to the depth of the made ground.

<u>Excavations</u>

10.25 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 made ground present on the site.

10.26 No groundwater ingress was encountered in any of the excavations or boreholes on site. Subsequent monitoring of the boreholes identified a very small amount of water to be present at the base of the monitoring installations but this is not considered to be representative of a continuous groundwater table. However, the investigations were undertaken in the summer months and it is possible the groundwater levels may be higher at other times of the year. Any encounters of groundwater should be controllable by pumping from an artificial sump.

10.27 Excavations should be readily achieved using conventional hydraulic plant. However, excavations into intact bedrock or any buried foundations and structures are likely to require a hydraulic breaker.

10.28 The exact location and extent of any subsurface features associated with the sluice is not known. The sluice was noted from the site walkover to be inactive but should it be required to keep the sluice intact then care with excavations will be needed when developing the site, and also with the imposition of any loads onto the feature.

Chemical Precautions

10.29 The Aggressive Chemical Environment for Concrete (ACEC) class is AC-3z for the natural strata and AC-5z for the made ground. Therefore, the use of FND3z designated concrete will be necessary for unreinforced buried concrete in natural ground and FND4z with added protections in made ground, in accordance with BS 8500-1:2006, if the existing made ground on the site is to be retained. For any reinforced buried concrete, other design-specific mixes will apply.

Road Pavement Construction

10.30 Due to the depth of existing made ground on the site, a formation for adoptable road pavement on natural strata is likely to be impractical. 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, partial excavation and replacement, with or without layers of geogrid, or the use of vibro stone columns overlaid by a geogrid reinforced stone blanket. The proposed measures will need to be agreed with the adopting authority and, therefore, consultations with the relevant authority should be undertaken at the earliest stage.

Party Wall Aspects

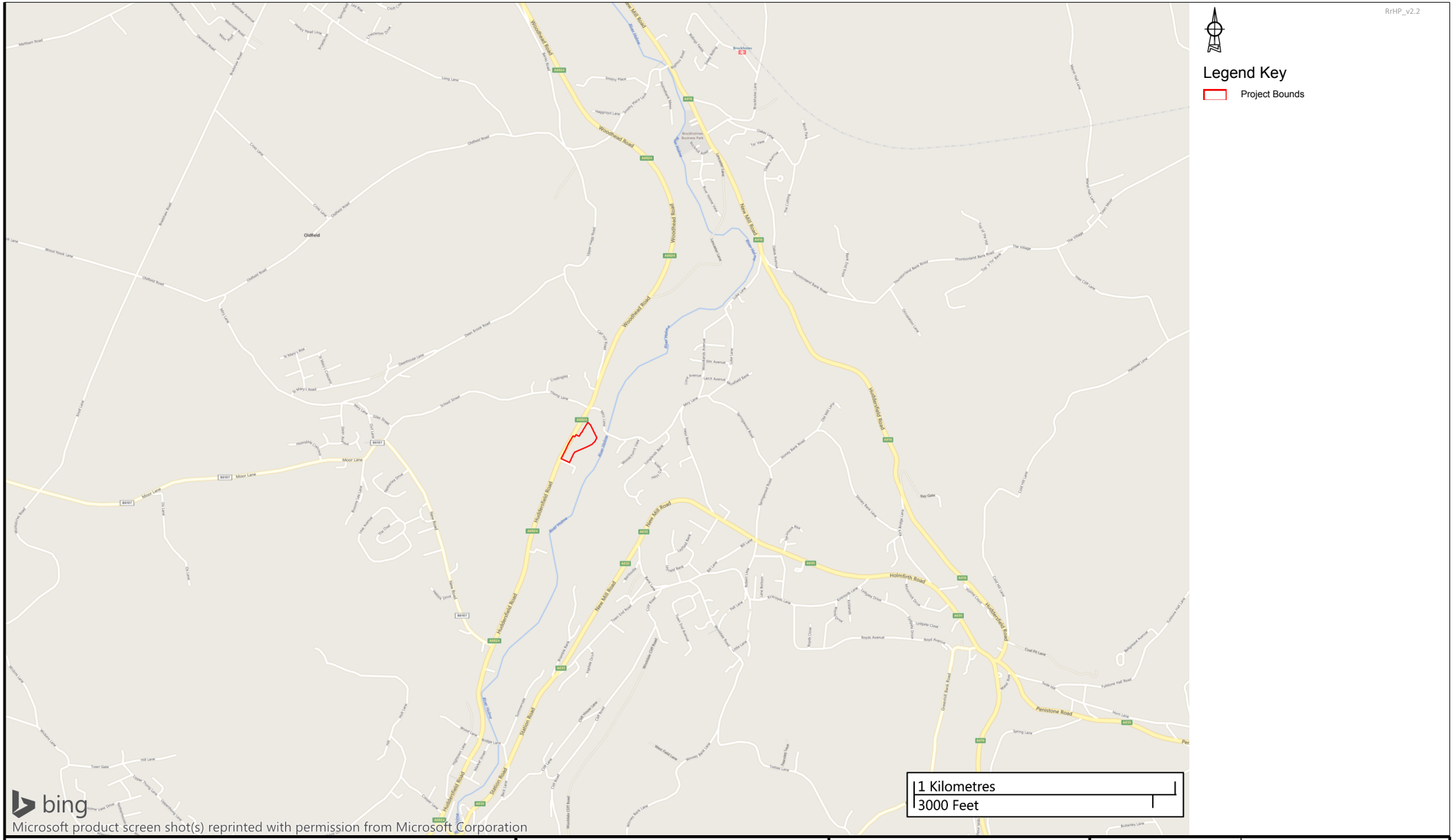
10.31 The proposed layout indicates that excavations may be required in close proximity to the site boundaries. The requirements of The Part Wall Act 1996 should be observed, and it is possible that a Party Wall Surveyor may need to be appointed.

Soakaways

10.32 The use of soakaway drainage is not considered feasible on the site, due to a combination of deep made ground and cohesive strata.

A P P E N D I X A

SITE LOCATION PLAN AND AERIAL PHOTOGRAPH



Project: Thongsbridge Mills	Title: Site Location Plan		Date: 02/11/2018	Scale: 1:20000
Client: Mr S Marsden			Drawn: AMJ	No: MSD/01

RrHP_v2.2

Legend Key

Project Bounds

Project: Thongsbridge Mills	Title: Site Layout Plan		Date: 02/11/2018	Scale: 1:2500
Client: Mr S Marsden			Drawn: AMJ	No: MSD/01

APPENDIX B

SITE PHOTOGRAPHS

Photograph 1: Looking towards the southwest at the access to the site.

Photograph 2: Looking towards the northeast across the site.

Photograph 3: Looking towards the northeast across the site.

Photograph 4: Looking towards the west and Huddersfield Road.