5. GEO-ENVIRONMENTAL ASSESSMENT

5.1 Approach

A number of generic risk assessments are undertaken in accordance with the principles of CLR 11 (Environment Agency 2004) using the CSM that has been updated following the ground investigation. Firstly, the risks associated with the identified potential contaminant linkages are estimated using standardised methods (typically involving comparison of site data with published 'screening values'. Secondly, where screening values are exceeded, the risks are evaluated in an authoritative review of the findings with other pertinent information to determine if exceedance may be acceptable in the particular circumstances. For details please refer to Appendix H.

The data sets used comprise the appropriate analytical results obtained by Hydrock and listed in Section 3.4 plus any suitable data from previous sources listed in Section 2.2.

In cases where unacceptable risks are indicated, mitigation measures such as more advanced stages of risk assessment or remediation will be proposed in Section 0.

5.2 Updated Exposure Model

Following the site investigation, the plausible contaminant sources, receptors and pathways identified in Section 2 have been updated or confirmed as follows.

5.2.1 Sources

No potential sources have been removed from, or added to, the exposure model.

5.2.2 Receptors

No potential receptors have been removed from, or added to, the exposure model.

5.2.3 Pathways

No pathways have been removed from, or added to, the exposure model.

With reference to the updated ground model and updated exposure model reported above, generic risk assessment is undertaken in Section 5. Geotechnical recommendations made in Section 7.

5.3 Human Health Risk Assessment

This is a Tier 2 assessment using soil screening values for the CLEA commercial land use scenario where soil organic matter is considered at a worst case scenario of 1%.

The soil screening values used are generic assessment criteria (GAC) and results are given in Appendix I. Note that the Category 4 Screening Levels (C4SL) for lead have been used as there are no recognised GACs and the use of the term 'GAC' in this report includes these.

Statistical testing is used where data sets are suitable. For data sets with low sample numbers and/or a non-random spatial distribution (e.g. where sampling is targeted at specific areas) individual sample test results are compared directly with the screening values. For the purposes of this assessment, the majority of samples were targeted and therefore statistical assessment is not appropriate and results will be compared directly to the GAC.

It should be noted that the phrase 'further assessment required' is used to denote soil concentrations that are equal to, or exceed, a GAC. This does not necessarily mean that the soil is 'contaminated' or not fit for use.

5.3.1 Risk Estimation (Without Statistical Testing)

Hydrock Default List of Determinands

The individual analytical results have been compared with the relevant GACs in the summary table in Appendix I. No substances exceed the GAC.

Asbestos

Asbestos was not identified as present in any of the samples submitted for analysis.

Petroleum Hydrocarbons (PHC)

Investigation locations surrounding areas previously identified as impacted by PHCs were chosen to delineate possible contaminant plumes and indicate possible migration of hydrocarbons. A total of 13No samples were submitted for speciated TPH testing (TPH-CWG). Of these 13No samples, 4No samples contained concentrations exceeding the relevant GAC. All exceedances were reported in TPH Aliphatic fraction EC12-EC16. The relevant GAC is of 24mg/kg.

The following samples exceeded the GAC:

- Within the River Terrace Deposits at 2.10m in BH302, reported at 360mg/kg.
- Within the Made Ground at 0.40m in BH304, reported at 86mg/kg.
- Within the River Terrace Deposits at 1.40m in BH309, reported at 190mg/kg.
- Within the River Terrace Deposits in BH310, reported at 72mg/kg.

Volatile Organic Substances (VOC)

Aliphatic EC12-16 fraction exceedances were recorded as detailed above. Lighter fractions carry a risk of vapour inhalation.

Volatiles and the Indoor Air Pathway

Where VOCs, including the lighter volatile fractions are present on the site, the GACs are controlled by the very high proportion of the average daily exposure that takes place through the inhalation of vapours inside buildings. Higher assessment criteria would be appropriate if vapours were to be prevented from entering buildings (for example, by the inclusion of suitably designed and installed organic vapour membranes). With this in mind, Hydrock has calculated Site Specific Assessment Criteria (SSAC) using the same CLEA UK model as for the calculation of GACs, but excluding the vapour pathway. These are intended to be used in a similar manner as the GACs, but represent the remaining exposure pathways. These SSACs are tabulated in Appendix H.

At this site, therefore, if vapour barriers were to be designed for the buildings or have been incorporated into existing structures the potential vapour pathway would be removed increasing the GAC to 94000mg/kg resulting in no exceedances, based on the results of recent testing.

5.3.2 Risk Evaluation

The screening exercise identified the following substance at concentrations above the GAC. This is considered further here to assess if the exceedance may be acceptable with respect to the proposed development.

Although the GAC for TPH fraction Aliphatic EC12-EC16 is exceeded in four locations on the site. These areas are already developed and in use by the present occupiers. Incorporation of organic vapour resistant membranes into the construction of proposed new buildings will be required in the identified areas.

BH302 and BH304 are located in close proximity to PBA 2015 BH105A, which previously identified a PHC impact. The southward rise in concentration may indicate that this impact is migrating from offsite in the area of the Tradebe operations to the south. Groundwater monitoring shows an approximate fall in groundwater level from south to north. This area is indicated for development on the site Masterplan (see Appendix A).

BH309 and BH310 are located in an area of the site formerly utilised for fuel storage tanks. The area has been recently developed with the erection of a warehouse storage unit situated on a concrete slab and surfacing of the yard area. It is not known if organic vapour resistant membranes were incorporated into the construction.

Exceedances range from 3 to 15 times the GAC of 24mg/kg for the model with inclusion of a potential pathway for organic vapours. When potential for this pathway is removed by way of incorporation of organic vapour resistant membranes, there are no exceedances of the GAC of 94000mg/kg.

5.4 Plant Life Risk Assessment

5.4.1 Risk Estimation

Priority phytotoxic chemical concentrations have screened against published values to determine the likely risk to plant growth and the findings presented in Appendix I. As with human health, statistical testing is used where data sets are suitable, otherwise individual sample test results are compared directly with the screening values.

Based on test results that exceed the GAC, the pervasive chemicals of potential concern which require further assessment are summarised in Table 5.1.

Table 5.1: Pervasive Chemicals of Potential Concern for Which Further Assessment is Required (Risk to Plants)

Chemical of Potential Concern	Generic Criterion (mg/kg)	Basis for Generic Criterion	No. Samples	Min. (mg/kg)	Max. (mg/kg)	No. Samples Exceeding Generic Criterion
Boron	3	New Zealand 1997	15	0.4	7	4

5.4.2 Risk Evaluation

Within the topsoil, Boron is slightly elevated when compared to the GAC. Detriment to plant life is hard to quantify and many of the GACs are based on agricultural crop yields rather than serious harm of death of a species. As the exceedance is slight and the vegetation on site has not been reported as showing any signs of physical distress, Hydrock does not believe any additional consideration is required with regards to risks to plant life. However, if proposed soft landscaping areas are to be planted with sensitive species, the placement of a suitable growing medium may be required. It is understood the species mix (supportive of heathland environment) is set out in the Design Guide and regime, including translocation of acid grasslands from development plots to communal areas, is set out in the Landscape Environmental Management Plan. These documents are to form part of the suite of documents submitted in support of the LDO.

5.5 Pollution of Controlled Waters Risk Assessment

5.5.1 Risk Estimation

The risks to groundwater and surface water from contaminants on site have been assessed according to the Environment Agency (2006) Remedial Targets Methodology (RTM).

Under the European Water Framework Directive (2000/60/EC) pollutants from contaminated land sites are considered as passive inputs. Inputs to surface waters and inputs of non-hazardous pollutants to groundwater and are regulated under the Agency's 'limit' pollution objective. As such, site contaminant loadings are compared with relevant threshold values (Water Quality Targets) which are linked to the conceptual site model. Acceptable WQT are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)).

The approach for hazardous substances in groundwater is to use the 'prevent' pollution objective. Acceptable WQT are listed by UKTAG (November 2013, amended January 2014) and are minimum reporting values (MRV), referred to in this report as HAZ-MRV.

For the purposes of this report, the site data are compared with the various targets as set out according to the Hydrock scenario D in Table 5.2 (see Appendix H for details), on the basis of the following:

- the Head Deposits, River Terrace Deposits and Poole Formation are classified as Secondary A and Secondary (undifferentiated) Aquifers and likely to provide base flow to the River Win running through the east of the wider site.
- there is a low risk of leachate entering the drains and the River Win which feeds into the River Frome, through surface water runoff or leachate migration.

Table 5.2: Summary of Water Quality Risk Assessment Protocol

Hydrock Scenario	Water Body Receptors	Secondary Receptors	Example Contaminant Linkages	RTM Level and Data Used	Water Quality Targets
D	Groundwater. Surface water.	Aquatic ecosystem.	Contaminants from site leach or seep into groundwater body and this feeds surface water by base flow. The surface water may be used for human consumption and is an aquatic ecosystem.	RTM Level 2 - Groundwater.	DWS EQS (inland) HAZ-MRV
Notes: Some EQS are water hardness dependent. This is measured either in the receiving water or in groundwater (if it is part of the pathway) or is estimated from national maps. Inland waters EQS applicable to freshwater, other waters EQS applicable to marine or transitional waters. Where both DWS and EQS are applicable, it is assumed that the EQS is for inland waters. This table and the results of the assessment are considered as a first screening for potential risks of pollution of Controlled Waters. More specific requirements may be stipulated by the relevant Agency.					

The results of the Remedial Targets Methodology assessment are presented in Appendix I and are summarised in Table 5.3.

It should be noted that in some instances the reporting limit (or detection limit) quoted by the laboratory may be greater than the WQT that it is being assessed against. As the current exercise is an initial screening assessment, further assessment of these elements has not been undertaken.

Table 5.3: Chemicals of Potential Concern for Which Further Assessment is Required (Controlled Waters)

Chemical of Potential Concern	Water Quality Target (ug/l)	Basis for Water Quality Target	No. Samples	Min. (ug/l)	Max. (ug/l)	No. Samples Exceeding Target
Cadmium	0.15	Inland Water EQS	6	0.02	2	2
Cobalt	3	Inland Water EQS	12	1.2	240	10
Chromium (VI)	3.4	Inland Water EQS	1	35	35	1
Copper	1	Inland Water EQS	12	1.6	10	12
Nickel	4	Inland Water EQS	12	1.9	85	1
Vanadium	20	Inland Water EQS	8	0.2	34	5
Zinc	10.9	Inland Water EQS	12	0.5	3300	4
pH	9	Inland Water EQS	12	6.5	11.1	1
Note: the maximum recorded value is compared with the water quality target.						

Petroleum Hydrocarbons in water were assessed by way of direct comparison of groundwater sample test results against Water Quality Targets (WQT) and water solubility. Whilst exceedances of WQT were reported (2No. Aromatic fraction EC10-12, 2No. Aromatic fraction EC12-16 and 1No. Aromatic fraction EC16-EC21), the water solubility values were not exceeded. WQT for these fractions are 10µg/l in each case, with maximum exceedance reported as 100 µg/l, 140 µg/l and 58 µg/l respectively.

A number of determinands have been reported to exceed the relevant water quality standards within the groundwater sample results. It is considered that the main risk to Controlled Waters is in relation to the surface water course, the River Win, which ultimately joins the River Frome. On this basis, additional water sampling of surface water sampling of the River Win has recently been undertaken as part of further Controlled Waters Risk Assessment at the site.

Surface water samples were collected from three locations; where the River Win enters the site in the south (SS1), the mid-point of the River Win running through the site (SS2) and where the River Win exits the site to the north (SS3). Sampling locations are indicated on the Exploratory Hole Location Plan (Appendix A). A direct comparison of surface water samples with WQT was undertaken in accordance with Hydrock Scenario F (see Appendix H for details). Results generated by the testing of collected water samples generally indicated that the waters did not exceed WQT for Inland Waters EQS, with the exception of those summarised in Table 5.4.

Table 5.4: Chemicals of Potential Concern for Surface Waters

Chemical of Potential Concern	Water Quality Target (ug/l)	Basis for Water Quality Target	SS1 (ug/l)	SS2 (ug/l)	SS3 (ug/l)	No. Samples Exceeding Target
Copper (dissolved)	1	Inland Water EQS	0.7	2.0	1.1	2
Nickel (dissolved)	4	Inland Water EQS	7.5	10	11	3
Zinc (dissolved)	10.9	Inland Water EQS	7.3	15	8	1

Dissolved Copper is noted to have slightly exceeded WQT at locations SS2 and SS3, with exceedance being marginal where the River Win leaves site.

Dissolved Nickel is noted to exceed the WQT at all three testing locations.

Dissolved Zinc is noted to have exceeded the WQT at SS2 only.

Whilst exceedances have been noted, these do not indicate that the Rive Win is necessarily impacted by virtue of its path through the site.

5.5.2 Risk Evaluation

The groundwater data indicate that the EQS are exceeded for metals (cadmium, cobalt, chromium VI, copper, nickel, vanadium and zinc) as well pH.

The groundwater gradient is to the north. The groundwater is likely to provide baseflow to the River Win and ultimately the River Frome to the north.

Surface waters sampled from the River win prior to it entering the site, at its mid-point on the site and after exiting the site do not indicate contamination sources on site are influencing the water quality within the River Win. Whilst exceedances of WQT are exceeded in several instances, the identified determinands may be related to background soil chemistry levels.

Although the evidence is not indicative the River Frome being impacted by virtue of its path through the site, it is considered that the development of the site could improve the water regime by reducing the surface area for infiltration and therefore reducing the impact of contaminant drawdown via leaching.

5.6 Ground Gases Risk Assessment

5.6.1 Assessment

The risks associated with the ground gases methane (CH4) and carbon dioxide (CO2) are assessed using BS 8485:2015 and guidance from CIRIA Report 665 (Wilson et al 2007). The development proposals require consideration of Situation A (all forms of development).

The guidance requires the calculation of Gas Screening Values (GSV). For the purposes of the calculation, where the recorded gas flow rate is below the manufacturer's limit of detection for the instrument used, the detection limit has been adopted for the gas flow rate.

Ground gas monitoring is ongoing. Six monitoring visits have been undertaken to date. The ground gas readings and gas regime conceptual model derived from the works to date are considered to be sufficient to provide a preliminary assessment of the ground gas regime and the likely scope of protection measures. The typical worst case GSV to date have been calculated as 0.008 l/hr for methane and 0.1 l/hr for carbon dioxide, classified as CS2 in accordance with Ciria Report 665. These figures are based upon a maximum concentration of 0.4% methane, 5.8% carbon dioxide and a maximum flow of 2.0l/hr.

The site is provisionally classified as within Characteristic Situation 2 (Situation A) for commercial/industrial buildings.

5.6.2 Gas Protection Measures

Based on the data to date, basic gas protection measures are required.

5.6.3 *Off-Site Risks from Carbon Dioxide and Methane*

The National Planning Policy Framework requires that a site should be incapable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990. This includes the potential for off-site migration of ground gases that may impact adjacent properties.

Consequently, it may be necessary to consider the imposition of measures to protect adjacent, off-site receptors. In this case as risk directly to the proposed development is considered minimal, risks associated with off-site migration of ground gas are considered negligible.

5.6.4 *Volatile Organic Compounds*

Concentrations of Aliphatic fraction EC12-16 have been found in excess of the GACs for the indoor air pathway, but below the GACs for the outdoor air pathway. In order to protect occupants of the buildings without recourse to soil remediation it will be necessary to install suitable VOC resistant barrier membranes.

5.6.5 *Ground Workers*

It is noted that concentrations of carbon dioxide (an asphyxiant) in the soil exceed HSE Workplace Exposure Limits for personnel in the working environment of 1.5% for short term (15 minutes) exposure and 0.5% for long term exposure. Furthermore, soil concentrations of oxygen are below the HSE recommendations of 18%.

Additionally, it was noted that elevated levels of carbon monoxide and low levels or absence of oxygen noted on occasion at BH309.

Whilst risks to construction workers are not generally discussed in this report, and soil gas concentrations are not necessarily reflected by those in the breathing zone, all contractors and maintenance workers should be made aware of the possible presence of carbon dioxide/monoxide plus absence of oxygen noted locally across the site and should take all necessary health and safety precautions when working in trenches or confined spaces.

5.7 The Wider Ecosystem Risk Assessment

The wider site is subject to the land designations of SAC, SPA, RAMSAR and SSSI although this does not extend to the development area discussed within this report. Ecological reports by Peter Brett Associates (2015) and Lindsay Carrington Ecological Services (2017) indicated that habitats within the site are considered to be of moderate to high ecological importance and set out a number of requirements relating to development and potential ecological enhancements that could be employed to offset loss of habitats through development.

Reports did not note any invasive species or ecological distress related to site or ground conditions.

5.8 Construction Materials Risk Assessment

5.8.1 *Water Pipelines*

The current guidance on selection of materials for potable water supply pipes to be laid in contaminated land is contained in a document published jointly by Water UK and the Home Builders Federation (Water UK HBF (2014)). The protocols in that document are for guidance and are not subject to enforcement by Water UK or any agency but have been adopted by Water UK and by HBF as best practice for their members. Accordingly, this guidance is used in the following assessment. For further details see Appendix H.

A formal water pipe risk assessment is beyond the scope of this report; however, the findings of this investigation have been compared to the threshold values in Water UK Table 1 as far as is practicable to give an indication of the possible restrictions to the use of plastic pipes for water supply to the site.

The site is brownfield and organic contamination has been identified in exceedance of the threshold values and Hydrock recommend the use of barrier pipe. However, confirmation should be sought from the water supply company at the earliest opportunity.

5.8.2 *Other Construction Materials*

If plastics or bitumastic building materials are to be incorporated into the construction of the proposed developments these may be at risk from attack from organics recorded on site should these be in contact, including vapours.

The implications for buried concrete are discussed in Section 7.10.

5.9 Findings of the Generic Risk Assessments

Particular areas of the site which are of potential concern are indicated on the Site Zonation Plan in Appendix A. Site-wide issues are not mapped on the plan but are listed in the notes. The source-pathway-receptor contaminant linkages given in

Table 5.4 are those which, following the risk evaluation process, require further consideration and are discussed further in Section 6.0.

Table 5.4: Final Conceptual Model and Residual Risks Following Risk Evaluation

Sources	Pathways	Receptors	General	Mitigation
Petroleum hydrocarbons at depth in the Made Ground and natural strata.	Inhalation of VOCs.	Human health.	Hotspot related to the former buried fuel tank and possible migration from offsite in the west. The depth of the contamination, existing structures and surfacing are considered means that only the vapour inhalation pathways are of concern.	Risk cannot be fully quantified without detailed vapour modelling, but as a precautionary measure and to mitigate against nuisance odours, mitigation measures are recommended.
Asbestos fibres from insulation or asbestos-containing materials in the buildings.	Inhalation of fugitive dust.	Human health (site neighbours).	Asbestos in old buildings.	Specialist removal will be required. However, removal under controlled conditions should limit potential for fibre release.
Elevated concentrations of metals and pH within groundwater	Lateral and vertical migration	Secondary A aquifers, River Win, River Frome	Potential for impact to Secondary A Aquifers and ecology of nearby River Systems	Reduction of surface area of infiltration through development of the site.

6. GEO-ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

6.1 Key Risk Drivers

6.1.1 Human Health

Two areas have been identified on site as being impacted by petroleum hydrocarbons (probable diesel contamination). Whilst the recorded levels could be of potential risk to human health where vapours are considered, the incorporation of organic vapour resistant membranes into proposed development structures in the vicinity of identified hotspots is sufficient to mitigate these risks. Identified areas of contamination are indicated on the Site Zonation Plan (DIP-HYD-XX-ZZ-DR-GE-1002) in Appendix A.

Organic materials in the vicinity of PBA 2015 Phase 2 TP3 were noted in Hydrock TP314 and TP315, although absent of anthropogenic components and comprising of peat with large root or trunk remains. Whilst ground gases may be present locally, the vicinity has recently developed as a building and associated free-standing signage. It is unknown whether gas membranes were incorporated into the design of the recent building construction.

6.1.2 Plant Life

Whilst Boron was noted at slightly elevated levels within the soils on site, no evidence of physical distress of existing plant life is reported by ecological reports to date. If areas of soft landscaping included in the proposed development are to be planted with sensitive species, suitable growing medium should be placed

6.1.3 Controlled Waters

A number of determinands have been reported to exceed the relevant water quality standards within the groundwater sample results. It is considered that the main risk to Controlled Waters is in relation to the surface water course, the River Win, which ultimately joins the River Frome. On this basis, additional water sampling of surface water sampling of the River Win has recently been undertaken as part of further Controlled Waters Risk Assessment at the site.

A number of determinands were reported to exceed to the relevant water quality standards within the surface water samples taken from the River Win. However, the results do not conclusively indicate that the elevated levels present are resultant from the Rivers passage through the site. Exceedances reported may be related to background soil chemistry of the area. A reduction in surface area for infiltration through development of the site is likely to reduce the impact of potential contaminant drawdown via leaching.

6.1.4 Ground Gases

Ground gas monitoring has classified the site as Characteristic Situation 2 scenario for the site.

6.2 Mitigation Measures

- Development within the areas identified as impacted by Petroleum Hydrocarbons (Aliphatic fraction EC12-16) should incorporate organic vapour resistant membranes into the design to reduce risk to human health from vapours in enclosed spaces (indoor environment). This vapour barrier should also incorporate protection from ground gas in accordance with CS2.
- Site preparation works are likely to include removal of asbestos from buildings by specialist contractors in accordance with the asbestos survey and relevant legislation, followed by controlled decommissioning, decontamination and demolition of site buildings and ancillary structures such as tanks and the existing drainage system.

- Earthworks on site should be subject to a watching brief by an independent geo-environmental specialist to identify any areas of suspected contamination and recommend remedial measures.
- No radon protection is required for new buildings at this location.
- The use of barrier pipe for potable water supplies is recommended.
- The reduction of infiltration surface area by way of development will aid in reduction of the potential contaminant drawdown via leaching.

6.3 Waste Management

Any material excavated on site may be classified as waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose. Further details are given in Appendix H.

If material is to be removed from the site (e.g. foundation arisings) the laboratory test results in Appendix I, should be presented to the proposed receiving landfill site (to aid Waste Characterisation), prior to export, to confirm that it is suitably licensed to accept them. Some additional testing may be necessary at the time of disposal for the receiving landfill to confirm the Waste Acceptance Criteria (WAC) are acceptable for it to receive the waste.

Based on the results of the testing it is anticipated that the natural excavated soils will be classified as inert for off-site disposal purposes for much of the site, notwithstanding those identified as impacted by petroleum hydrocarbons and containing predominantly organic materials (peat). However, this will depend on the results of the WAC testing. If the soils are not proven to be inert, they may be classified as non-hazardous.

Non-hazardous soils require pre-treatment prior to disposal. Effective pre-treatment, involving separation, sorting and screening can offer cost reductions through reducing the hazardous nature and volume of soil waste. Costs for disposal of non-hazardous/hazardous soils are significant compared to disposal of inert material.

6.3.1 HazWasteOnline™ Assessment

In order to inform the waste characterisation process, Hydrock has undertaken a preliminary exercise using the proprietary web-based tool HazWasteOnline™, to characterise the soils encountered in the investigation.

Based on the HazWasteOnline™ output, the soils sampled that may be classified as hazardous are summarised in Table 6.1, all remaining soil samples are classified as non-hazardous. The results of the output are included in Appendix J.

Table 6.1: HazWasteOnline summary

Location	Depth (m)	Classification	Hazard Properties	Influencing determinand	Concentration
BH302	2.10	Hazardous	Carcinogenic Mutagenic Flammable	TPH (C6-C40) petroleum group	0.115%
BH304	0.40	Potentially Hazardous	Flammable	TPH (C6-C40) petroleum group	0.0674%
BH309	1.40	Potentially Hazardous	Flammable	TPH (C6-C40) petroleum group	0.0723%
TP310	0.50	Hazardous	Corrosive	pH	11.7

With regards to petroleum hydrocarbons, based upon carbon banding of the TPH, the findings of the investigation and the way the PHC are distributed within the soil, it is likely that the potential for the soil being hazardous on account of HP3i can be all but discounted. However, this can be confirmed only by subjecting the material flash-point testing. It would be reasonable to assume that the result would indicate that the soil would be non-hazardous as a result of the TPH content.

Further testing of the soils (WAC testing) may be required in order to satisfactorily categorise the soil for its suitability for disposal at an inert or a hazardous landfill site.

6.3.2 Waste Recommendations

Prior to disposal, the characteristics of any excavated soils will need classification in consultation with landfill sites and waste disposal contractors. Testing and analysis will be required to be carried out on the actual soil arisings which will constitute the waste.

6.3.3 Materials Management

Any material excavated on site may be classified as waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose.

If site-won material is to be re-used on site, a Materials Management Plan will be required, signed off by a Qualified Person as defined in the 'Development Industry Code of Practice' (CL:AIRE, March 2011).

7. GEOTECHNICAL ASSESSMENT

7.1 Geotechnical Categorization of the Proposed Development

Eurocode 7, Section 2 advocates the use of geotechnical categorization of the proposed structures to establish the design requirements.

The illustrative masterplan does not include specific details on building design, however it is reasonable to assume that future buildings will typically include low-rise office blocks and light industrial / warehouse units. Where traditional strip or pad foundations can be used these structures are classified as being Geotechnical Category 1 (although pads may potentially be Category 2, depending on the loading). However, where piled foundations are required the structures would be Geotechnical Category 2.

The recommendations given in the following sections should be considered to be a preliminary guide for outline design purposes only and will need to be revised as necessary once detailed design plans have been finalised. Additional ground investigations may be required to inform the detailed foundation and floor slab design. A specific Geotechnical Design Report is required where Category 2 structures are proposed.

7.2 Groundwork

7.2.1 Site Preparation – Buried Obstructions

It is presumed that the redevelopment will involve demolition of the existing buildings.

Buried concrete slabs were encountered at PBA exploratory hole locations BH118, BH118A and BH118B (all at 0.3m bgl); TP213 (at 1.6m bgl in the northern end of the pit); at TP217 (at 0.6m bgl in the southern end of the pit); and at Hydrock location TP303 (at 0.75m bgl). In addition, large concrete blocks were also recorded in the western end of trial pit TP310 at a depth of 1.6m bgl, and sections of demolished wall were recorded in PBA trial pit TP207 at 0.9m bgl.

It should be noted that the PBA Phase 2 report also includes references to concrete obstructions at BH113 and REC locations WS101 to WS104. However, a review of the logs for those boreholes indicates that this referred to the surface hardstanding, which comprised a thin layer of asphalt overlying concrete to a depth of 0.3m bgl.

The Master Specification supplied by the Client states "Since previous ground condition assessment reports were produced a large number of buildings have been removed largely only to ground level." It is therefore anticipated that there is a high potential that relict foundations, floor slabs and possibly infilled basements will be encountered during the redevelopment of the site.

Consequently, it is recommended that an allowance be made for breaking out obstructions, for example provision of pneumatic breakers for site plant. If underground structures cannot be removed, they will need to be surveyed in three dimensions and the new structures will need to be designed to accommodate them.

Topsoil and unsuitable Made Ground should be removed from beneath all building and hardstanding areas.

7.2.2 Groundworks

Following breaking out of hardstanding and/or obstructions, excavation of shallow soils should be readily undertaken by conventional plant and equipment. However, excavation through any buried construction may require heavy-duty excavation plant and the use of specialist breaking equipment.

Instability of excavation faces was noted during excavation of some of the trial pits. This is prevalent in the natural coarse soils, often where groundwater entries were recorded.

Random and sudden falls should be expected from the faces of near vertically sided excavations put down at the site. This situation is likely to be prevalent in the Made Ground and natural coarse soils and is likely to be exacerbated by water inflows.

Temporary trench support, or battering of excavation sides, is likely to be required for all excavations that are to be left open for any length of time and will definitely be required where man entry is required. Particular attention should be paid to excavation at, or close to, site boundaries, adjoining existing roads and any nearby structures, where collapse of excavation faces could have a disproportionate effect.

A risk assessment of the stability of any open excavation should be undertaken by a competent person and appropriate measures adopted to ensure safe working practise in and around open excavations. Further guidance on responsibilities and requirements for working near, and in, excavations can be obtained from the Construction Design and Management Regulations (2015).

Recorded groundwater levels were locally shallow within the River Terrace Deposits. It should be recognised that groundwater levels will fluctuate seasonally and the timing of construction may dictate the extent of groundwater control required. It may not be possible to control groundwater ingress by simple pumping and alternative dewatering options may need to be considered.

Any water that is pumped from excavations is likely to need to be passed via settlement tanks before being discharged to the sewer; discharge consents will also be required.

At this stage, Hydrock is not aware of proposals for re-levelling of the site. However, it may be necessary to consider reuse of existing soils as part of redevelopment proposals. Should earthworks be required, an Earthworks Specification will be necessary to ensure the appropriate management and reuse of the existing soils. Once site proposals have been further defined more specific consideration will need to be given to the re-use of materials and reference should be made back to this office if an earthworks specification is required. The earthworks may need to be undertaken under a Materials Management Plan (see Section 6.3.3).

7.2.3 Earthworks/Reuse of Site-Won Materials

Spoil resulting from excavations within the Made Ground should be suitable for re-use as general fill subject to further testing and specification, with the exception of areas subject to petroleum hydrocarbon impact.

An initial assessment has been completed on the potential to re-use site-won materials as an engineered fill material, which indicates the soils which are likely to be re-used can be classified as follows:

- Made Ground - Class 2 granular (less than 15% passing the 63µm sieve) - General Fill.
- River Terrace Deposits - Class 2 granular (less than 15% passing the 63µm sieve) - General Fill.

Where it is proposed to re-use site won materials as an engineered fill, it will be necessary to develop an appropriate Site-specific Earthworks Specification (as part of the GDR, should Category 2 or 3 structures be proposed) which can be adopted as part of the contract documentation. The basis for the Specification should be BS 6031:2009 and the latest version of the SHW, Series 600 Earthworks.

7.3 Foundations

The proposed development is for a commercial business park, which is anticipated to include the construction of low-rise office blocks and light industrial / warehouse buildings.

The Made Ground and shallow, locally loose, River Terrace Deposits are considered unsuitable in their present condition for use as founding soils on the basis of their relatively low strength and should be fully penetrated by all new foundations. For traditional strip or pad foundations, soils of sufficient bearing capacity for the presumed light industrial / commercial units and low rise office blocks have been identified at depths of between 1.2m and 2.8m bgl. Where structures within the proposed development are to be heavily loaded or are likely to be sensitive to settlement it is considered that these should be found upon the deeper more consistent deposits of the Poole Formation which is likely to necessitate the adoption of piled foundations.

Groundwater ingress was generally absent or slow (i.e. seepages) during the excavation of the trial pits and boreholes, which also generally remained stable. However, it should be noted that post-fieldworks groundwater monitoring identified a relatively high water table beneath the site (typically in the region of c.1.5m bgl, but locally as shallow as 1.0m bgl). Groundwater observations during site works were typically of slow seepages indicating water inflows into any excavations may be readily controlled using standard pumping techniques. Therefore, it may be possible to use traditional strip or pad foundations subject to level of ingress of water to foundation excavations.

It is recommended that pumping tests are undertaken at the site prior to the proposed development commencing to determine the degree of water control required. Should the tests indicate that the degree of water control would make the use of strip or pad foundations impractical, then piled foundations would be required.

7.3.1 Strip or trench fill foundations

Traditional strip or trench fill foundations may be suitable for the proposed development, provided the groundwater conditions can be effectively and economically overcome.

Based on the design soil parameters provided in earlier sections of this report, as a guide, an allowable net bearing pressure of 100kN/m² should be available for a strip or trench fill foundation bearing at least 300mm into the natural medium density sands and gravels of the River Terrace Deposits. This value includes a factor of safety of 3 against general shear failure and should result in total settlements of not more than 25mm for foundations up to 1m wide, keeping differential settlements within acceptable limits.

Excavation of trench fill foundations to depths in excess of 2.5m bgl is unlikely to be economical and may be impracticable to undertake. Care should be taken to ensure the verticality of deep, narrow foundations to prevent eccentric loading.

NB: should enlarging the foundations be considered (for example because loads are such that the quoted bearing pressure is inadequate based on the size of foundation identified) this will probably lead to increased settlements and the above recommendations should be reviewed.

7.3.2 Pad foundations

Pad foundations may also be an appropriate solution for the proposed development, depending on the results of the recommended pumping tests.

Based on the design soil parameters provided in earlier sections of this report, as a guide, an allowable net bearing pressure of between 100 kN/m² (where N-value =10) and 315 kN/m² (where N-value = 30) should be available for pad foundations bearing at least 300mm into the natural medium dense sands and gravels of the River Terrace Deposits. N-Values were typically observed to increase with depth (see Appendix E). These values apply for pads of between 1m x 1m and 2m x 2m inclusive, and include a factor of safety of 3 against general shear failure and should result in total settlements of not more than 25mm, keeping differential settlements within acceptable limits.

NB: should enlarging the foundations be considered (for example because loads are such that the quoted bearing pressure is inadequate based on the size of foundation identified) this will probably lead to increased settlements and the above recommendations should be reviewed.

7.3.3 Piled Foundations

Should they be required, driven piles or bored piles with the use of casing should be suitable for this site. However, the choice of piling system and detailed design of piles are beyond the scope of this report and should be undertaken by a specialist piling contractor, taking into account the following considerations.

- Obstructions in the ground, such as old foundations can cause piles to stop at shallower than design depth, or deviate from the vertical, thereby reducing their capacity.
- Pile, and in particular bored pile, installation can create preferential pathways for the migration of contaminants to the groundwater.
- Boring of piles in coarse soils is likely to result in loosening of the soils, with resultant reduced shaft friction.
- Shallow groundwater was observed during the post-fieldwork monitoring and temporary casing is likely to be required for bored piles unless CFA piles, with placement of concrete as the pile is withdrawn, are used.
- Piles should extend a minimum of five pile diameters into the bearing stratum to fully mobilise end-bearing resistance.
- The potential effects of negative skin friction on piles.
- Care should be taken for bored and cast in situ piles taken through the Made Ground and locally loose sands and gravels, where collapse of the pile shaft or running sand conditions could lead to 'necking' of the pile.
- The Made Ground will provide only minimal lateral resistance and piles should be designed to be sufficiently rigid, and to have sufficient embedment into the founding soils to minimise the risk of unacceptable lateral movement.

A further important consideration is the presence of the railway line adjacent to the northern site boundary. It is recommended that discussions with Network Rail are held regarding the use of piling close to the railway line.

7.4 Heave Protection

Shallow Foundations

For traditional or pad foundations, deepening of foundations in accordance with BRE 298 will be required where clay soils are exposed at formation level and foundations are within the zone of influence of existing, removed or proposed trees and proposed shrub planting. For existing (and any known removed) trees this will require a tree survey to be undertaken by an arboriculturist in accordance with BS 5873:2012 which must include off-site trees that could have an effect on foundation design, in addition to trees on site.

Where foundations are within the influence of trees and are deeper than 1.5m bgl, a suitable compressible material or void former will be required.

Where foundations require deepening to greater than 2.5m below ground level, it is recommended that they be designed by a geotechnical engineer.

Piled Foundations

Where piled foundations are constructed though clay soils within the influencing distance of trees including proposed planting, the upper section of the pile (to the recommended minimum founding depth) should be sleeved or over-bored to allow for clay volume change.

7.5 Piling Risk Assessment

A risk assessment is likely to be necessary for piling, as there is a possibility that this could lead to creation of new pathways for migration of contamination.

7.6 Working Platform

For piling, a working platform will be required prior to the arrival on site of tracked plant. This should be designed and installed in accordance with BR470 (BRE 2004) based on data on the piling plant in accordance with an FPS certificate for the rig loadings.

7.7 Ground Floor Slabs

Prior to the placement of the founding materials and the construction of a ground bearing floor slab, the sub-formation and formation will need to be inspected and checked by a geotechnical engineer to ensure the ground conditions are as expected. In accordance with The Concrete Society Technical Report 34 (The Concrete Society 2013), this shall include the measurement of modulus of sub-grade reaction (k) determined by static plate load testing to confirm the ground conditions at time of construction are consistent with the design parameters derived from this ground investigation.

Following excavation and testing, suitable imported granular material should be placed and compacted in accordance with a suitable specification such as the Specification for Highway Works (Highways Agency 2014). Incorporation of triaxial geogrid reinforcement at sub-formation level, directly below the compacted granular material, will minimise required excavation depths and help provide a suitable foundation for the ground bearing slab.

The floor slab should be of sufficient thickness and sufficiently reinforced to accept the likely loading from commercial vehicles parked on it and any other applied loads, without unacceptable total or differential movement.

Ground floor slabs should be designed to incorporate any gas mitigation measures that may be required as discussed within the previous sections of this report.

7.8 Roads and Pavements

Based on the test results acquired by PBA, it is considered likely an equilibrium CBR of 3% will be achievable over the majority of the site and can be used for preliminary design, subject to in situ testing during construction.

Proof rolling of the formation level will be required and any loose or soft spots should be removed and replaced with an engineered fill, in accordance with a suitable Specification. The formation level will also need to be protected during inclement weather from deterioration; all slopes should be trimmed to falls to shed rain water and the surface sealed to limit infiltration.

Prior to the placement of the founding materials and the construction of the road pavement, the sub-formation and formation will need to be inspected and checked in accordance with a suitable specification to ensure the ground conditions are as expected. All testing should be carried out in accordance with DMRB IAN 73/06 to confirm that the ground conditions at time of construction are consistent with the previous design parameters.

Where the CBR is found to be less than 2.5%, the sub-grade may be unsuitable for both the trafficking of site plant and as support for a permanent foundation, without improvement works being undertaken. Improvement works should be carried out in accordance with DMRB IAN 73/06 Rev 1 Chapter 5. In summary, consideration may be given to the following potential remedial techniques:

- excavation and re-engineering or replacement of weaker soils;
- the inclusion of geosynthetic reinforcement within the unbound layers of the capping and sub-grade;
- where cohesive soils are present and they are deemed suitable for treatment with hydraulic binders, to employ modification and/or stabilisation techniques on the formation; and
- where granular soils are present, de-watering and re-engineering the formation.

7.9 Soakaways and Drainage

Soakaway testing carried out by PBA recorded calculated soil infiltration rates of between 2.34×10^{-4} to 8.23×10^{-5} m/s at two locations, however at two further locations soil infiltration rates were too low to allow calculations to be carried out. These values indicate that soakaway drainage may be feasible for the site, subject to further, confirmatory testing.

7.10 Buried Concrete

Based on guidelines provided in BRE Special Digest 1 (BRE 2005), the soils can be classified as Design Sulfate Class DS-2 and ACEC Class AC-2 (see Section 4.3.1).

This equates to a Design Chemical Class DC-2 for a 50-year design life (see BS 8500-1:2006 for details).

8. UNCERTAINTIES AND LIMITATIONS

8.1 Site-Specific Comments

Whilst recent investigations targeted areas of demolished buildings, the footprints of the buildings have not been investigated in their entirety and existing buildings that are likely to be demolished as part of the proposed development were at the time of investigation occupied and therefore not investigated.

Investigations in the Atlas compound and surrounding area were limited by the recent construction of storage facilities.

It is unknown at present whether petroleum hydrocarbon contamination is migrating into the River Win and River Frome.

The source of petroleum hydrocarbon contamination in the west of the site (BH105A) is unknown and is considered likely to be off-site.

The risk from petroleum hydrocarbons in the vicinity of BH105A and WS101 may be mitigated by suitable remediation works which could include mass excavation of impacted soils or installation of a vapour barrier into new buildings. There may be a risk present within existing buildings and it is not known whether these buildings contain any vapour protection.

Surveying and testing of materials within drainage features was not within the scope of this report, although these have been identified as possible conduits for contaminants.

Radionuclide levels recorded along the boundary fence in the vicinity of the Tradebe facility indicate an offsite source of radiation. The nature of the source is not known.

8.2 General Comments

This report details the findings of work carried out in January and February 2018. The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, all potential environmental constraints or liabilities associated with the site may not have been revealed.

The report has been prepared for the exclusive benefit of Purbeck District Council and those parties designated by them for the purpose of providing geotechnical and geo-environmental recommendations for the site. The report contents should only be used in that context. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

Hydrock has used reasonable skill, care and diligence in the design of the investigation of the site. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

Groundwater findings described are only representative of the dates on which they were made and levels may vary.

Unless otherwise stated, the recommendations in this report assume that ground levels will remain as existing. If there is to be any re-profiling (e.g. to create development platforms or for flood alleviation) then the recommendations may not apply.

Information provided by third parties has been used in good faith and is taken at face value; however, Hydrock cannot guarantee its accuracy or completeness. It is assumed that previous reports provided have been assigned to the Client and can be relied upon. Should this not be the case Hydrock should be informed immediately as additional work may be required.

The work has been carried out in general accordance with recognised best practice. The various methodologies used are explained in Appendix H. Unless otherwise stated, no assessment has been made for the presence of radioactive substances or unexploded ordnance. Where the phrase 'suitable for use' is used in this report, it is in keeping with the terminology used in planning control and does not imply any specific warranty or guarantee offered by Hydrock.

The chemical analyses reported were scheduled for the purposes of risk assessment with respect to human health, plant life and controlled waters as discussed in the report. Whilst the results may be useful in applying the Hazardous Waste Assessment Methodology given in Environment Agency Technical Guidance WM3, they are not primarily intended for that purpose and additional analysis may be required should waste classification be required for consideration of off-site disposal of contaminated soils. Separate analyses will be required to meet the Waste Acceptance Criteria for specific landfill sites.

Unless otherwise stated, the chemical testing carried out for this report was not scoped to comply with the requirements of the water supply company and further work may be required.

The preliminary risk assessment process may identify potential risks to site demolition and redevelopment workers. However, consideration of occupational health and safety issues is beyond the scope of this report.

Please note that notwithstanding any site observations concerning the presence or otherwise of archaeological sites, asbestos-containing materials or invasive weeds such as Japanese knotweed, this report does not constitute a formal survey of these potential hazards.

Any site boundary line depicted on plans does not imply legal ownership of land.

9. RECOMMENDATIONS FOR FURTHER WORK

Due to the relatively high water table beneath the site and the instability of the Made Ground and loose, near-surface natural soils, piled foundations will be required. Therefore, the following further works will be required:

- pre-demolition asbestos survey;
- arboricultural survey in relation to foundations and potential heave;
- in-situ CBR testing proof rolling and improvement works during roadway and pavement construction;
- the carrying out of pre-development pumping tests at the site to determine the degree of groundwater control that would be required to allow the use of strip/trench fill or pad foundations;
- discussions with piling contractors regarding their method for emplacing piles;
- discussions with Network Rail regarding the use of piling close to the railway line adjacent to the north of the site;
- discussions with service providers regarding the materials suitable for pipework etc.;
- assessment of recent additional surface water sampling of the River Win as part of further Controlled Waters risk assessment.
- discussions with regulatory bodies regarding the conclusions of this report;
- foundation depth in relation to trees assessment, following a review of recently completed tree survey to BS 5837:2012;
- provision of a Geotechnical Design Report for Category 2 structures;
- detailed design of foundations;
- assessment of potential risk to existing site users from petroleum hydrocarbon vapours/ground gases to include review of existing building construction;
- production of Remediation Method Statement;
- remediation of the site; and
- verification of the remedial works.

10. REFERENCES

ALLEN, D. L., BREWERTON, L. J., COLEBY, L. M., GIBBS, B. R., LEWIS, M. A., MACDONALD, A. M., WAGSTAFF, S. J. and WILLIAMS, A.T. 1997. The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R&D Publication 8.

ASSOCIATION OF GROUND INVESTIGATION SPECIALISTS. 2006. Guidelines for Good Practice in Site Investigation. Issue 2. AGS, Beckenham.

BOYLE, R. and WITHERINGTON, P. JANUARY 2007. Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present. Report No. 10627-R01(04). NHBC, Milton Keynes. 93pp + apps.

BRE. 1980. Low-rise buildings on shrinkable clay soils: Part 1. BRE Digest 240. Building Research Establishment, Garston, 4pp.

BRE. 1999. The influence of trees on house foundations in clay soils. BRE Digest 298. Building Research Establishment, Garston, 8pp.

BRE. 1991. Soakaways. BRE Digest 365. BRE, Garston.

BRE. 2004. Working platforms for tracked plant: good practice guide to the design, installation, maintenance and repair of ground-supported working platforms. BR470. BRE, Garston.

BRE. 2005. Concrete in aggressive ground. BRE Special Digest 1, 3rd Edition. BRE, Garston.

BRITISH STANDARDS INSTITUTION. 1986. British Standard Code of practice for Foundations. BS 8004. BSI, London.

BRITISH STANDARDS INSTITUTION. 2003. Geotechnical investigation and testing - Identification and classification of rock - Part 1: Identification and description. BS EN ISO 14689-1 Incorporating Corrigendum No.1. BSI, London

BRITISH STANDARDS INSTITUTION. 2004. Eurocode 7 – Geotechnical design - Part 1: General rules. BS EN 1997-1. Incorporating Corrigendum No.1. BSI, London.

BRITISH STANDARDS INSTITUTION. 2006. Concrete – complementary British Standard to BS EN 206-1 – Part 1: Method of specifying and guidance to the specifier. BS 8500-1. BSI, London.

BRITISH STANDARDS INSTITUTION. 2007. Eurocode 7 – Geotechnical design - Part 2: Geotechnical investigation and testing. BS EN 1997-2. BSI, London.

BRITISH STANDARDS INSTITUTION. 2009. Code of practice for earthworks. BS 6031 Incorporating Corrigendum No.1:2010. BSI, London.

BRITISH STANDARDS INSTITUTION. 2011. Code of Practice for Investigation of Potentially Contaminated sites. BS 10175 Incorporating Amendment No.1:2013. BSI, London.

BRITISH STANDARDS INSTITUTION. 2012. Trees in relation to design, demolition and construction – Recommendations. BS 5837. BSI, London.

BRITISH STANDARDS INSTITUTION. 2015. Specification for topsoil. BS 3882. BSI, London.

BRITISH STANDARDS INSTITUTION. 2015. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. BS 8485. BSI, London.

BRITISH STANDARDS INSTITUTION. 2015. Code of practice for ground investigations. BS 5930. BSI, London.

CARD, G., WILSON, s. and MORTIMER, S. 2012. A pragmatic approach to ground gas risk assessment. CL:AIRE Research Bulletin RB17. CL:AIRE, London.

CIEH and CL:AIRE. May 2008. Guidance on comparing soil contamination data with a critical concentration. Chartered Institute of Environmental Health and Contaminated Land: Applications in Real Environments, London, 66pp.

CL:AIRE. March 2011. The Definition of Waste: Development Industry Code of Practice, Version 2. Contaminated Land: Applications in the Real Environment (CL:AIRE), London.

CLAYTON, C.R.I. 1995. The Standard Penetration Test (SPT): methods and use. CIRIA Report R143, CIRIA, London.

CONCRETE SOCIETY, THE. 2013. Concrete industrial ground floors. A guide to design and construction. Technical Report 34 (4th Ed.). The Concrete Society, Camberley. 88pp.

DEFRA. March 2014. SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. Defra, London.

ENVIRONMENT AGENCY. 2004. Model procedures for the management of land contamination. Contaminated Land Report 11. The Environment Agency.

ENVIRONMENT AGENCY. 2006. Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination. The Environment Agency, Bristol, 123pp.

ENVIRONMENT AGENCY. 2015. Waste classification. Guidance on the classification and assessment of waste (1st Ed.) Technical Guidance WM3. The Environment Agency.

HATANAKA, M. and UCHIDA, A. 1996. Empirical correlation between penetration resistance and effective friction of sandy soil. Soils & Foundations, 36 (4), 1-9. Japanese Geotechnical Society.

HEALY, P.R. & HEAD, J.M. 1984. Construction over abandoned mine workings. CIRIA Special Publication SP32. CIRIA, London.

HIGHWAYS AGENCY. 2009. Design Guidance for Road Pavement Foundations (Draft HD25). Interim Advice Note 73/06. Rev 1. Highway Agency, London.

HIGHWAYS AGENCY. 2014. Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1, Amendment August 2014. Highway Agency, London.

JOHNSON, R. 2001. Protective measures for housing on gas contaminated land. Building Research Establishment Report BR 414. BRE, Garston.

JONES, H. K., MORRIS, B. L., CHENEY, C. S., BREWERTON, L. J., MERRIN, P. D., LEWIS, M. A., MACDONALD, A. M., COLEBY, L. M., TALBOT, J. C., MCKENZIE, A. A., BIRD, M. J., CUNNINGHAM, J. and ROBINSON, V. K. 2000. The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report WD/00/04. 234pp. Environment Agency R&D Publication 68.

LORD, J.A., CLAYTON, C.R.I. and MORTIMORE, R.N. 2002. Engineering in Chalk. CIRIA Report C574. CIRIA, London.

MALLETT, H., COX, L., WILSON, S., and CORBAN, M. 2014. Good practice on the testing and verification of protection systems for buildings against hazardous ground gases. CIRIA Report C735. CIRIA, London.

MILES, J. C. H., APPLETON, J. D., REES, D. M., GREEN, B. M. R., ADLAM. K. A. M. and MYRES. A. H. 2007. Indicative Atlas of Radon in England and Wales. Health Protection Agency and British Geological Survey. Report HPA-RPD-033.

Ministry of Housing, Communities & Local Government. July 2018. National Planning Policy Framework (NPPF).

NHBC. 2014. NHBC Standards, Part 1 Introduction and Technical Requirements. NHBC, Milton Keynes.

NHBC. 2014. NHBC Standards, Part 4 Foundations. NHBC, Milton Keynes.

NHBC. 2014. NHBC Standards, Chapter 4.2 Building near trees. NHBC, Milton Keynes.

RAWLINS, B. G., McGRATH, S. P., SCHEIB, A. J., CAVE, N., LISTER, T. R., INGHAM, M., GOWING, C. and CARTER, S. 2012 .The advanced geochemical atlas of England and Wales. British Geological Survey, Keyworth.

SCIVYER, C. 2015. Radon: Guidance on protective measures for new buildings. Building Research Establishment Report BR 211. BRE, Garston.

STONE, K., MURRAY, A., COOKE, S., FORAN, J. and GOODERHAM, L. 2009. Unexploded ordnance (UXO), a guide to the construction industry. CIRIA Report C681. CIRIA, London. 141 pp.

STROUD, M. A. 1975. The standard penetration test in insensitive clays and soft rocks. Proceedings of the European Symposium on penetration testing, 2, 367-375.

UKTAG. November 2013 (updated January 2014). Updated recommendations on environmental standards. River Basin Management (2015-21). UK Technical Advisory Group on the Water Framework Directive.

WATER UK HBF. January 2014. Contaminated Land Assessment Guidance. Water UK and the Home Builders Federation. 12pp.

WELSH ASSEMBLY GOVERNMENT. July 2004. Development and flood risk. Planning Policy Wales, Technical Advice Note 15.

WFD-UKTAG. July 2014. UKTAG River & Lake Assessment Method, Specific Pollutants (Metals), Metal Bioavailability Assessment Tool (M-BAT). Water Framework Directive – United Kingdom Technical Advisory Group. Stirling.

WILSON, S., OLIVER, S., MALLETT, H., HUTCHINGS, H. and CARD, G. 2007. Assessing risks posed by hazardous ground gases to buildings. CIRIA Report C665. CIRIA, London. 182pp.

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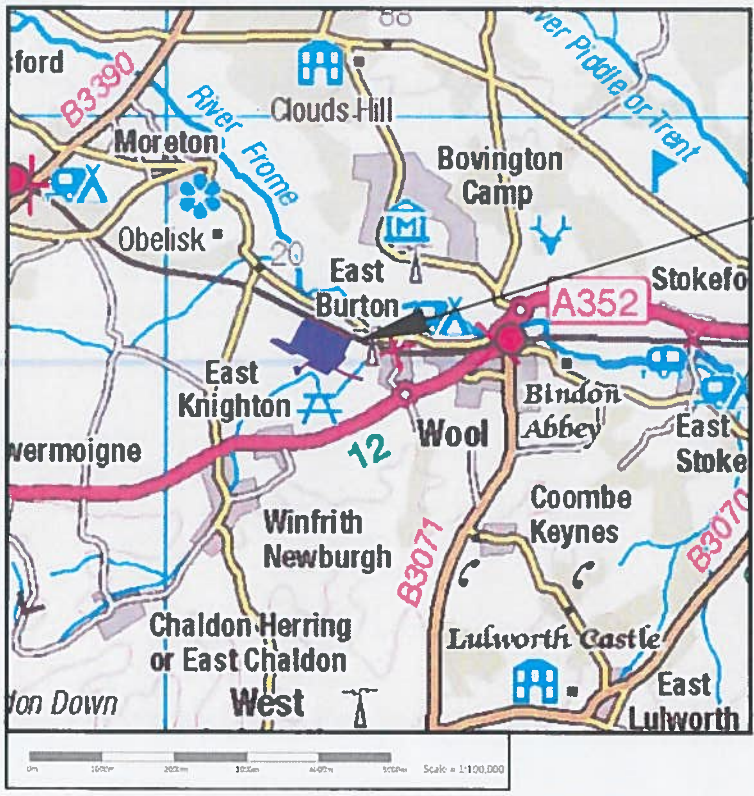
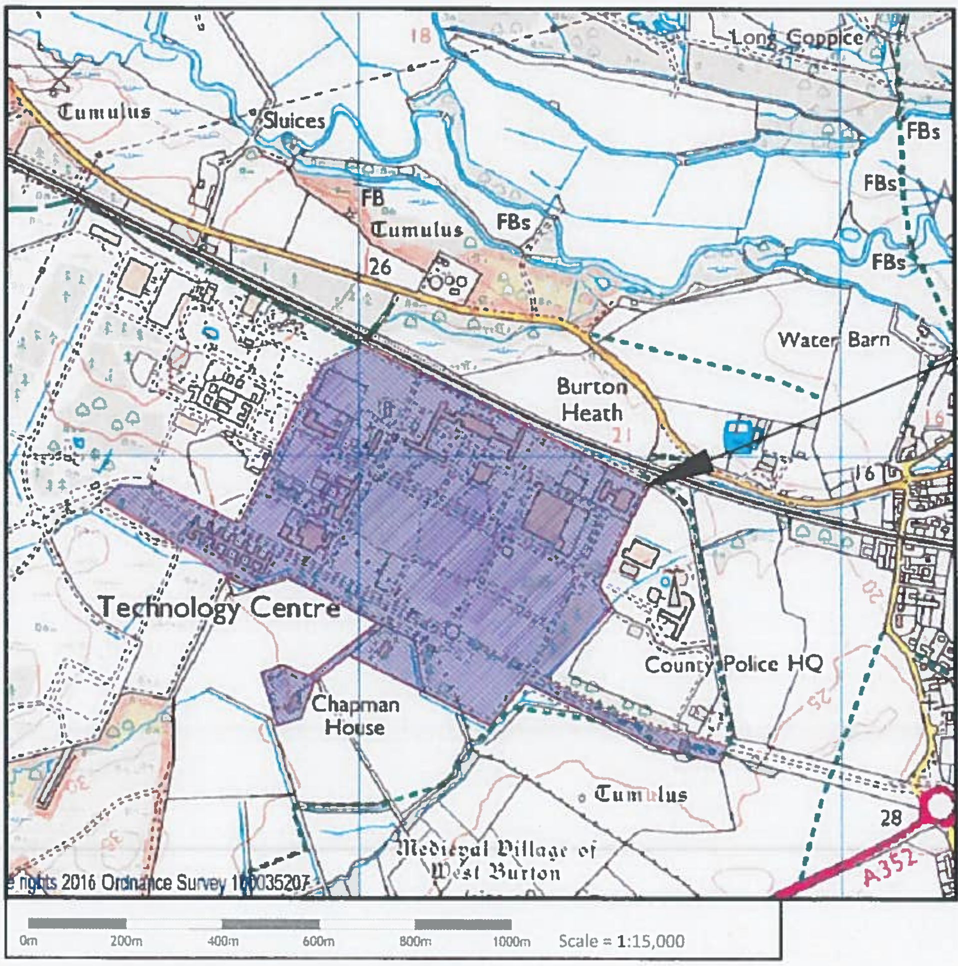
Appendix A Drawings

Notes:

1. Contains Ordnance Survey data © Crown copyright and database right 2017





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PURBECK DISTRICT COUNCIL

DORSET INNOVATION PARK
WOOL, DORSET

Site Location Plan

DIP-HYD-XX-ZZ-DR-GE-1000

C-08277-C

Drawn	Checked	Scale @ A3	Date	Issue Date
SD	AJ	See Drawing	06/04/18	06/04/18

Revision	Status
P1	S2