A PHASE II CONTAMINATION REPORT TO SUPPORT A RESIDENTIAL DEVELOPMENT ON LAND AT:

MAGELLAN WAY, SPALDING



CLIENT: **John Retchless**

REFERENCE: **BJH/17.330/PhaseII**

DATE: **31 October 2017**

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1. INTRODUCTION

A F Howland Associates Limited was instructed by John Retchless (the 'Client') to carry out a Phase II Contamination Survey on land at Magellan Way, Spalding (Fig. 17.330/PhaseII/1). This was required to address part ii of condition 3 of planning permission, referenced H16-0330-17, for a single dwelling which will be constructed on an elevated platform partially over an existing pond.

This report was prepared for the use of the Client and its advisors. Other parties using the contained information do so at their own risk and any duty of care to those parties is specifically excluded. The report has been carried out in general accordance with accepted best practice and methodologies (BSI, 2013) (DEFRA and EA, 2004) (DCLG, 2010).

2. TERMS OF REFERENCE

This report has been prepared to support the proposed development and follows on from a Phase I desk study report (AFHA, 2017a) which should be referred to for the background data pertinent to the scheme.

The desk study concluded that there was the potential for contaminated soils to exist on the site from a former rail track adjacent to the eastern boundary and suspected vegetable and packaging waste used to partially infill the existing pond. Domestic gardens are not proposed but there is a possibility for infrequent exposure to contaminated soils and the pond water was also considered to be at risk of impact from the potential contamination. Buildings and services were also considered to be at a moderate/low risk from aggressive chemicals.

This Phase II investigation was therefore intended to:

- investigate the shallow ground conditions across the site and sample and analyse for contamination in the near surface soils, pond sediment and pond water.
- assess the risks to human health, controlled waters (the pond), buildings and services
- comment on mitigation and/or remediation strategies.

The comments and recommendations contained within this report are based on data acquired from relevant exploratory holes and associated laboratory testing. Extrapolation between and to other parts of the site is considered within the light of the geo-environmental setting as interpreted, but no responsibility can be accepted for conditions varying from those on which the report is based.

3. INTRUSIVE INVESTIGATION

3.1 FIELDWORK

The fieldwork, pertinent to the Phase II investigation, was carried out on 20 September 2017 and included two window sample holes, two hand dug trial pits and sampling of pond water. In addition, a single dynamic probe was carried out to provide parameters for foundation design and the results of this are included in a separate report (AFHA, 2017b).

The exploratory holes and sampling locations were selected to target potential infilled land in the proposed soft landscaping area of the development and to allow samples of the soils, pond sediment and pond water to be collected. The locations are shown on drawing 17.330/PhaseII/2. The National Grid references, and the elevation of the exploratory holes relative to Ordnance Datum, were measured using a Hemisphere S320 VRS GPS (RTK) system. A cable avoidance tool (CAT) and other detection equipment were also used to sweep the locations of the trial pits and surrounding areas to locate any services.

Sampling, soil descriptions and *in situ* tests were carried out in accordance with BS EN1997-2:2007 Eurocode 7 and its UK National Annex supported by BS 5930: 2015. Dedicated environmental samples were placed in suitable containers, stored in cool boxes and delivered to a UKAS accredited facility for analysis of potential contaminants.

The **window sample** holes, referenced WS01 and WS02, were advanced with a tracked window sampling rig to depths of 3.0 and 4.0 m respectively. The sampling system utilises a 63.5 kg weight falling a distance of 750 mm to drive rods and sampling tubes into the ground, these are then extracted and the continuous samples described, with sub-samples taken for possible laboratory testing. During advance, standard penetration tests (SPT) were carried out using a split barrel sampler to assist with foundation design. The SPT N value was taken as the number of blows for 300 mm of penetration, following a seating drive of 150 mm or 25 blows.

The **trial pits**, referenced POND and DP01-IP, were excavated by hand to a depth of 0.3 and 1.2 m respectively. DP01-IP was excavated to clear for the presence of services prior to advancing the dynamic probe but the soils were sampled and the findings are therefore relevant to this assessment. The pits were logged *in situ* and representative disturbed samples were taken for laboratory testing. Upon completion the trial pits were backfilled

with arisings. The trial pit, referenced POND, was excavated into the sediment at the base of the pond to take a sample. In addition a sample of pond water was also taken.

The exploratory holes were monitored for groundwater ingress during drilling. Where encountered advancement was temporarily ceased and the water level allowed to rise. However, such observations are affected by the permeability of the ground, the rate of progress of the hole and the excavation techniques in operation. The general procedures used do not allow precise measurements of the groundwater conditions, but give only a general guide to the overall situation. Fluctuations in any groundwater table will occur as a result of seasonal or climatic effects, as well as other outside influences.

Details of the strata encountered, the sampling and laboratory testing are shown on records appended to this report.

3.2 GROUND CONDITIONS

3.2.1 Soils

Made ground was found at each exploratory hole location to a maximum depth of 2.5 m. The pond sediment comprised a clayey sandy gravelly silt. Where encountered the natural ground was found to comprise organic clay, silt and sand considered to represent the mapped Tidal Flat Deposits.

The made ground was generally found to comprise dark brown or brown sand. A variable gravel content comprising flint and limestone was recorded as well as anthropogenic material including brick, tile, plastic, concrete, clinker, timber, plastic bags, suspected asbestos containing cement board and metal. Occasional whole bricks were recorded as well as layers of burnt material and ash. In WS01, the made ground was found to comprise black organic clay with timber and organic fragments and a plastic bag. This material had an organic odour and was interpreted to be former sediment in the base of the pond before it was infilled.

In WS01, the underlying natural soils comprised very soft brown mottled black organic clay between 1.89 and 2.36 m overlying grey silt, which had an organic odour, to the base of the hole at 3.0 m. In WS02, the interface between the made ground and the natural sand was interpreted to be at 2.5 m but poor recovery in the window sample liner prevented an exact depth to be determined. The sand was found to be silty and to have an organic odour and was proved to the base of the hole at 4.0 m.

3.2.2 Groundwater

Groundwater was encountered during fieldwork in WS01 and WS02 at depths of 1.7 and 1.9 m respectively. This subsequently rose to 1.3 and 1.72 m after 20 minutes. These depths correspond with levels of 1.83 and 2.09 m above Ordnance Datum (aOD) and approximately coincide with the water level in the pond at the time of the investigation which was recorded to be 1.74 m aOD.

4. QUANTITATIVE RISK ASSESSMENT

4.1 PROPOSALS

It is understood the proposed scheme will involve the construction of a residential dwellings on a raised platform elevated over a pond that has previously been partially infilled. The proposed layout is shown on Parsons and Whittley Drawing 3204.19 Rev.B included in Appendix D.

4.2 LABORATORY TESTING

The testing programme included analysis for a generic suite of contaminants for total concentrations in samples of soil, pond sediment and a sample of pond water. In summary, the samples were tested for the following:

- heavy metals/metalloids (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc)
- cyanide and phenol
- total and speciated PAHs (USEPA-16)
- BTEX[1], MTBE[2] and petroleum hydrocarbons (Criteria Working Group banding in soil)
- Ammoniacal nitrogen and phosphate
- Organic matter content (soil and pond sediment only).
- Asbestos fibres and bulk material (soil and pond sediment only).

4.3 HUMAN HEALTH RISK ASSESSMENT

4.3.1 Assessment Methodology

Whilst the dwelling is to be constructed on a raised platform, the existing ground below this and surrounding the pond presents an exposure route to contaminated soils. However, exposure will be infrequent and therefore it can be considered to represent an 'open space near residential housing' scenario for the purposes of a human health risk assessment.

[1] Benzene, Toluene, Ethylbenzene, p and m-xylene and o-xylene
[2] Methyl Tertiary Butyl Ether

The results for the analysis on four samples of made ground soil taken from the area below the proposed raised dwelling and one sample of pond sediment are presented in Appendix C as analytical report reference 684810-2. This also provides the stone and moisture content where applicable.

The results have been assessed against human health guideline values produced by Land Quality Management Limited in association with the Chartered Institute of Environmental Health (LQM, 2015) and which are referred to as 'suitable for use levels' (S4ULs). The S4ULs provide generic assessment criteria (GAC) values from a risk based approach to human exposure through the pathways of inhalation, ingestion and dermal contact which have been derived using the CLEA software version 1.06 and Environment Agency guidance (Environment Agency, 2009).

When relevant S4ULs were unavailable, such as in the case of antimony, lead and cyanide, the results were compared to alternative 'soil screening values' (SSVs). For antimony and cyanide, the SSV was derived by WS Atkins Consultants Limited (W S Atkins, 2017), using the ATRISKsoil programme. For lead, 'category 4 screening levels' (C4SLs) were used which have been developed by Contaminated Land: Applications in Real Environments (CL:AIRE, 2014) using a modified version of the CLEA model. The derivation of C4SLs uses the concept of a low level of toxicological concern (LLTC), which represents the estimated concentration of a contaminant that would pose an 'acceptably low' risk to human health. These allow a higher (though still 'acceptably low') level of risk while maintaining the precautionary approach. An 'open space near residential housing' scenario and a soil organic matter of 6% has been used for the assessment.

4.3.2 Results

The results can be summarised as follows:

Soil

- A single concentration of lead was above the C4SL upper threshold of 760 mg/kg within sample ES1 taken from DP01-1P at 0.3 m. The recorded concentration was 6100 mg/kg.
- Concentrations of all other heavy metals/metalloids tested were below screening levels.
- Concentrations of all PAHs (USEPA-16) were below screening levels.

- Concentrations of BTEX, MTBE and petroleum hydrocarbons were below screening levels and mostly below the limit of detection.
- Asbestos fibres were not detected but a single piece of suspected ACM was recorded in WS02.

Pond Sediment

Concentrations of all contaminants were below the selected screening levels in the pond sediment.

4.3.3 Discussion

The C4SL values for lead are based on the LLTC values derived by CL:AIRE (2014) which are based on renal and cardiovascular effects of lead in adults and neuro-behavioural effects in children. Values exceeding the upper threshold should be considered further or action should be taken to remove or reduce the likelihood of exposure. A concentration of lead in excess of the upper C4SL threshold was only found within one sample of made ground. The other three samples tested were found to contain lead concentrations of between 92 and 180 mg/kg which is below the lower C4SL threshold. Whilst a piece of suspected asbestos containing material (ACM) was encountered in the made ground in WS02 at a depth between 0.32 and 0.76 m, the soil matrix within this depth or elsewhere on the site did not contain asbestos fibres.

4.4 CONTROLLED WATERS RISK ASSESSMENT

4.4.1 General

The site is underlain by superficial Tidal Flat Deposits and bedrock of the Oxford Clay Formation which are both classified as unproductive. The River Welland is located 70 m from the eastern boundary of the site. The desk study concluded that there was a very low risk to groundwater and that contamination was unlikely to migrate to the River Welland. However, the pond on the site was considered to be sensitive and there was the potential for this to have been impacted by contamination from the material used to partially infill it.

The investigation found made ground in the area below the proposed dwelling which supports the evidence that this area had been infilled. The results of the soil and pond sediment analysis showed some elevated levels of metals, PAH and petroleum hydrocarbons. To identify if the pond has been impacted and assess the general quality

of the water a sample of pond water was analysed for the suite of contaminants presented above.

4.4.2 Assessment Methodology

The results of the analysis of pond sediment and pond water samples are presented in the appended report referenced 684810-2. These have been compared to screening values for ecological and chemical status of surface waters as given in Schedule 3 of the Water Framework Directive (WFD) (DEFRA, 2015).

4.4.3 Results

The results of the pond water analysis are summarised below:

- The concentration of ammoniacal nitrogen of 980 µg/l is considered to be moderate when compared against the ammonia standard for lakes.
- The concentration of phosphate, as an indicator for phosphorous levels, is considered to be high when compared to the standards for freshwater and brackish lakes.
- The concentration of copper of 1.4 µg/l is slightly above the standard for freshwater pf 1 µg/l. However, a review of the bioavailable fraction of copper using the UKTAG metal bioavailability assessment tool (EA, 2013) and typical values of dissolved oxygen content (DOC) and hardness (Ca in mg/l) of 6 and 75 mg/l respectively returns a site specific 'predicted no effect concentration' (PNEC) of 26.07 µg/l.
- Elevated concentrations of some petroleum hydrocarbon compounds were reported. These were typically found within the range of C10 to C35 for aliphatic and aromatic fractions. There are no specific guidelines for petroleum hydrocarbons in surface water although CL:AIRE (2017) state that the products must not:
    - form a visible film on the surface of the water or form coatings on the beds of watercourses and lakes,
    - impart a detectable 'hydrocarbon' taste to fish,
    - produce harmful effects in fish.
- PAHs were mostly below screening levels or the limit of detection. Only low concentrations of phenanthrene (0.06 µg/l) and pyrene (0.05 µg/l) were detected. Whilst there are no screening levels for these compounds, the World Health

Organisation (WHO, 2011) report typical concentrations of the sum of selected PAHs to be between 1 ng/l and 11 µg/l. The maximum sum of PAHs recorded in the pond water was 0.14 µg/l.

4.4.4 Discussion

The pond water has exhibited some contaminants to be higher than the recommended values for surface waters. The concentration of ammoniacal nitrogen was considered to be moderate and is therefore not a cause for concern but the concentration of phosphate is considered to be high. Whilst phosphate is an essential element for plant life, too much of it in water can speed up eutrophication[3]. Phosphate, which generally occurs from the use of fertilisers, was found to be generally low in the soil and pond sediment, which suggests that the soil is not the source of this nutrient. It is more probable that surface run-off has caused an increase in phosphate levels in the water. Likewise, petroleum hydrocarbons were elevated in pond water but not replicated at high concentrations in soil and pond sediment and there was no visible film on water surface or sediment. It is therefore likely that these have been introduced to the pond by surface run-off from the surrounding roads.

Concentrations of metals, particularly of lead, were not replicated in the pond water sample but, with the exception of lead, were of a similar order of magnitude in the pond sediment. The metals in the soil are therefore not considered to be soluble or pose a risk to the pond water.

The levels of PAH and copper are not a cause for concern.

A Preliminary Ecological Appraisal has been prepared for the site (Torc Ecology Limited, 2015). This states that the site was noted as providing a mosaic of different habitats which may therefore support a varied invertebrate assemblage. The pond was, however, noted to be choked by reeds. It was considered that by clearing small areas of the reed bed the potential habitats would be improved allowing a more diverse mix of established plants and new growth. The ecology appraisal goes on to say that the design of the development is not considered to constitute a significant negative impact on any habitats of conservation value. However, pollution control measures should be implemented

[3] Excessive richness of nutrients in a lake or other body of water which causes a dense growth of plant life

throughout development works to ensure no contamination of the pond and associated habitats.

4.5 BUILDINGS AND SERVICES

4.5.1 Water Supply Pipe Assessment

The suitability of plastic water supply pipes has been assessed by comparing the results of chemical analysis with the Anglian Water 'Pipe Selection Table' which is derived from Table 3.1 of the UKWIR report reference no. 10/WM/03/21 (2010). This shows that based on the contaminants analysed polyethylene (PE) or polyvinylchloride (PVC) water supply pipes will be suitable.

4.5.2 Buried Structures

Selected soil and water samples were subject to analysis for chemicals that may be aggressive to concrete and steel. The results can be summarised as follows:

- pH values between 7.2 and 8.1 in soil and 7.6 in groundwater
- water soluble sulphate (SO_4) from 0.1 to 3.48 gl^{-1} in soil and 0.06 gl^{-1} in water
- acid soluble sulphate (SO_4) between 0.12 and 1.5% in soil
- total sulphur value of between 0.07 and 2.7% in soil

The sulphur determination was made to complement the sulphate testing according to the recommendations of Building Research Special Digest 1 (BRE, 2005). This establishes if a material is pyritic and uses a relationship between total sulphur, acid soluble, water soluble sulphate, and total potential sulphate (TPS), to determine whether it is necessary to increase the Design Sulphate (DS) class. The results are presented in table 1 below and show that three of the samples of organic natural ground from WS01 produced oxidisable sulphides above the 0.3% trigger concentration, suggesting that the material contains pyrites.

Hole Reference	Sample Depth	Sample Reference	Acid Soluble Sulphate (%S04)	Total Sulphur (%)	Total Potential Sulphate (%S04)	Oxidisable Sulphides (%S04)	Pyritic Potential?
DP01-1P	0.30	D1	0.15	0.07	0.21	0.06	No
WS01	1.70	D4	1.50	2.7	8.10	6.60	Yes
WS01	2.00	D7	0.12	0.15	0.45	0.33	Yes
WS01	2.40	D8	0.16	0.32	0.96	0.80	Yes
WS02	0.80	D5	0.24	0.1	0.30	0.06	No

Table 1: pyritic potential of soil for assessment of concrete grade

In addition, the corrosivity classification for the soil with respect to buried steel can be determined with reference to table 8.1 of The Design Manual for Roads and Bridges, Volume 2 (The Highways Agency, 2001). This uses soil properties as well as chemical content to establish the corrosivity classification using a points system. This returns a score of -11 which corresponds with a very aggressive classification.

4.6 CONSTRUCTION WORKERS

Anglian Water guidance (AWS, 2011) lists a number of metals and organic contaminants with associated soil guideline values (SGV) which is partly based on Environment Agency Contaminated Land Exposure Assessment (CLEA) advice (Environment Agency, 2009a and 2009b). It should be noted that the SGVs are formulated from research into long-term chronic exposure pathways, and are not directly applicable to short-term contact such as that experienced by construction workers. Nevertheless the results for the principal analytes are summarised in table 2 below.

Contaminant	SGV from AW guidance (mg/kg)	Highest Value Recorded in Testing (mg/kg)
Arsenic	32	23
Nickel	130	1.6
Mercury	170	1.6
Selenium	35	9
Cadmium	10	130
Benzene	0.33	0.011
Toluene	610	<0.001
Ethylbenzene	350	<0.001
Xylenes	230	<0.001
Phenol	420	<0.007

Table 2: Contaminant risk to construction workers

Overall, this suggests that short-term contact with spoil during the construction period is unlikely to pose a significant hazard. However, mitigation should be considered due to the presence of cadmium which was recorded between 0.3 and 130 mg/kg. Asbestos fibres were not detected but a piece of suspected ACM was recorded in WS02. Risk management and mitigation is discussed in section 5.

4.7 CONCEPTUAL MODEL

Following assessment of the chemical analysis the conceptual model presented in the desk study has been revised and is presented in table 3 below. Risk management and

remediation measures are discussed in Section 5, where appropriate. Risk assessment classification is appended.

Source of Contamination	Pathway	Receptor	Probability and Reasoning	Consequence and Reasoning	Risk Classification
Contaminated soils at shallow depth in the soft landscaping below the proposed elevated building and pond sediment	Direct contact, inhalation, ingestion	Human end-users	**Low likelihood** – domestic gardens not proposed but may be infrequent exposure from soft landscaping. High concentration of lead in a single sample	**Medium** – residential end-use but raised dwelling will give rise to infrequent exposure only. Mitigation required to reduce exposure to lead contamination	**Moderate/Low Risk**
		Construction workers	**Low likelihood** – with the exception of cadmium, contaminant concentrations are generally low when considering short term exposure by construction workers	**Mild –** short term exposure but can be controlled by use of PPE, suitable hygiene practices and dust suppression	**Low Risk**
	Percolation of leachate / mobile contaminants	Groundwater	**Unlikely** – generally low levels of contamination and not thought to be soluble. Strata below the site are unproductive and of low sensitivity	**Minor** – no aquifers present, the site is not in a source protection zone and no potable water abstractions nearby	**Very Low Risk**
		Surface water	**Unlikely** – the pond appears to be impacted by phosphate and low levels of petroleum hydrocarbons. Not thought to arise from the site and probably come from surface run-off	**Medium** – the pond is considered sensitive but the advice of an ecologist is recommended for appropriate action to increase the suitability for diverse habitats	**Low Risk**
	Direct Contact	Concrete and Steel	**Likely** – natural organic soil is potentially pyrite bearing. Shallow soil has an extremely high corrosivity classification to steel	**Medium –** robust receptor but appropriate concrete grade and foundation materials should be adopted	**Moderate Risk**
		Water supply pipes	**Unlikely** – significant levels of contaminants that permeate plastic water supply pipes have not been recorded	**Medium –** PE or PVC water supply pipes are suitable	**Low Risk**
Partially infilled pond and potentially infilled land off site	Gas migration and accumulation in structures	Human end-users	**Unlikely** – made ground and organic natural ground recorded and may be generating ground gas. No pathway into the raised dwelling	**Severe** - acute risk to potential end users	**Low Risk**[1]
		Structures			**Low Risk**[1]
Radon Gas		Human end-users	**Unlikely** – site outside of radon affected area	**Medium** - chronic risk to human end users	**Low Risk**

Notes: [1] a low risk classification is concluded based on the probability and consequence of the lack of a significant gas pathway due to the raised building making this risk low or negligible.

Table 3: Revised conceptual model

5. RISK MANAGEMENT AND MITIGATION MEASURES

5.1 INTRODUCTION

The review of risk and assessment of appropriate management or remediation is based on the presence of a "source-pathway-receptor". In the absence of the linkage, the risk is eliminated. The discussion below is based on the findings of the investigation and is therefore limited to the areas investigated. If any suspected contamination is encountered during the construction phase then this should be evaluated and appropriate action taken.

5.2 CHEMICAL CONTAMINATION – HUMAN END-USERS

A moderate/low risk to human end-users from the concentration of lead within the made ground from the area below the proposed elevated dwelling is concluded. A domestic garden is not proposed and therefore conventional gardening activities will not take place and disturbance of the ground will be minimal. The isolated piece of potential ACM recorded in WS02 was not replicated elsewhere and asbestos fibres were not found in the soil matrix. Routine excavation and mixing of the soil is highly unlikely, since gardening activities will be limited to occasional maintenance, planting or scrub clearance. Therefore there is not considered to be a significant risk from asbestos fibres being released from disaggregated ACM and only short-term exposure to the lead contamination may occur. A conventional cover system is therefore considered appropriate. For assessing the suitability of a cover system, the short term exposure model from the BRE 465 guidance (BRE, 2004) has been used. Using the model shown in Figure 5 of the guidance, a relative exposure of 0.1 occurs regardless of the cover thickness. A cover thickness of soil of 200 mm is therefore considered suitable in the soft landscaping. Any other areas of soft landscaping proposed in areas where levels are to be raised should include at least 200 mm of soil at the surface that is confirmed to be suitable for use in a residential setting.

The pond sediment was found to be suitable for use in the context of the development and therefore could be placed on the site surface following dredging.

As with any remedial activities, this approach should be agreed with the Local Planning Authority through the submission of a Remediation Method Statement and be subject to appropriate validation after construction.

5.3 CHEMICAL CONTAMINATION – CONTROLLED WATERS

Soil contamination levels were mostly found to be low. Furthermore, contaminant levels in the pond water did not replicate those in the soils or in the pond sediment. It is considered likely that the high levels of phosphate and relatively high concentrations of some petroleum hydrocarbons have accumulated through surface run-off. High phosphate levels can cause eutrophication and, whilst this has not been confirmed to be taking place, an ecology appraisal in 2015 recorded that the pond was choked with reeds. Nevertheless, the appraisal also stated that management of the pond and removal of some of the reeds would improve the habitat potential. The ecology appraisal also recommends that the landscaping and planting schedule should be reviewed by a suitably experienced ecologist to ensure that any new planting on site does not introduce any species which may be detrimental. It is concluded that the made ground soil recorded on the site is not having a significant impact on the pond water and, providing the advice of the ecology appraisal is followed, suitable habitats will be maintained or introduced.

The strata below the site is considered to be unproductive and therefore at very low risk. The distance to the nearby River Welland and the low permeability deposits recorded would inhibit lateral flow of any contaminants and the river is therefore at low risk.

5.4 CHEMICAL CONTAMINATION – CONSTRUCTION WORKERS

Soil analysis has revealed generally low levels of contaminants any contamination that may pose a short-term risk to construction workers. Cadmium was found to be in excess of the Anglian Water guidance levels for working in soil and mitigation procedures including standard personal protective equipment, the wearing of gloves when handling soils and hygiene precautions such as washing hands before eating should be adopted. A single piece of suspected ACM was recorded in the made ground although asbestos fibres were not detected. In accordance with good site practice, exposed soils and stockpiled soils should be damped down during dry weather to reduce dust generation and the likelihood of asbestos fibres becoming airborne.

5.5 CHEMICAL CONTAMINATION – WATER SUPPLY PIPES

Chemical analysis of soils reveals that plastic water supply pipes would be suitable for the development.

5.6 CHEMICAL CONTAMINATION – STRUCTURES IN AGGRESSIVE GROUND

Chemical analyses were undertaken in order to evaluate any aggressive tendency of the soil to buried concrete and steel. The pH results indicate slightly alkaline conditions, while the sulphate results corresponded with a design sulphate class for concrete of a maximum of **DS-4** according to Building Research Establishment Special Digest 1 (BRE, 2005).

The Digest identifies a number of different site categories, which include those with 'natural' soil conditions, those that have been subject to 'brownfield' development, and also sites which contain pyrite bearing ground that will be subject to future disturbance and could result in pyritic oxidation.

Laboratory testing suggests that pyritic conditions are likely within the natural organic ground. Furthermore, the underlying Oxford Clay bedrock is also considered to be pyritic. The design sulphate class for concrete should therefore be increased to **DS-5** to take into account the characteristic values of total potential sulphate. The Digest also shows that it is necessary to consider other factors related to the environment into which the concrete will be placed i.e. the pH of the soil and the mobility of the groundwater table. It is then possible to assign an ACEC (aggressive chemical environment for concrete) class.

Mobile groundwater conditions are likely, and as the pH is higher than 2.5 in a 'brownfield' setting the guidelines indicate that an ACEC classification of **AC-5** would be appropriate for buried concrete. Providing these measures are implemented for buried concrete a low risk is concluded.

The shallow soil has been identified to be extremely aggressive to buried steel.

5.7 GROUND GAS

No significant sources of ground gas have been identified off site. The partial infilling of the pond has resulted in the presence of made ground with a high organic content. The natural ground was also found to be organic. However, whilst degradation of the organic material may produce ground gas, the elevation of the proposed dwelling and therefore the presence of a significant void below the floor would remove the potential pathway for ground gas into the structure. The site is also outside of an area where the natural soils would generate a significant quantity of radon gas. A low or negligible risk from ground gas is therefore concluded.

5.8 WASTE SOIL DISPOSAL

Any surplus soil that is generated during construction and destined for removal off site should be disposed of in accordance with waste disposal regulations. The properties of the soil and pond sediment have been classified with respect to waste disposal and this is presented under a separate report (AFHA, 2017c). The pond sediment is suitable for use within the site based on the recorded contaminant levels.

6. SUMMARY

1. A Phase II investigation was carried out to address part ii of condition 3 of planning permission, referenced H16-0330-17, for a single dwelling that will be constructed on an elevated platform partially over an existing pond at Magellan Way, Spalding
2. The investigation confirmed that made ground was present where the pond had been partially infilled. This extended to a maximum depth of 2.5 m and contained anthropogenic material including brick, tile, plastic, concrete, clinker, timber, plastic bags and suspected asbestos containing cement board and metal. This was underlain by organic superficial deposits comprising clay, silt and sand. Groundwater was recorded at a resting level of between 1.3 and 1.72 m below ground level.
3. Chemical analysis revealed concentrations of lead in the made ground above assessment criteria for an 'open space near residential housing' scenario. This poses a moderate/low risk to human end-users. It is unlikely that there will be significant disturbance by end-users such that asbestos fibres will be released from the single piece of suspected ACM.
4. A very low risk to groundwater and a low risk to the River Welland was concluded. The Pond on the site was found to be impacted by phosphate and low levels of petroleum hydrocarbons. These contaminants were not replicated in the soil samples and therefore the source is considered to be from surface run-off from off site. Providing the recommendations of an ecology appraisal are followed the existing habitats will be maintained or improved.
5. A low risk to water supply pipes from hydrocarbon contamination was concluded. Plastic water supply pipes are considered suitable.
6. The natural soils have been found to be potentially pyrite bearing. A design sulphate class for concrete of DS-5 and an aggressive chemical environment for concrete class of AC-5 is recommended for buried concrete. The shallow soil has been identified to be extremely aggressive to buried steel.
7. No significant off site sources of ground gas have been identified. Organic made ground and natural soils have been recorded and have the potential to be producing ground gas. However, the elevation of the proposed dwelling and therefore presence of a significant void would remove the likelihood of build-up of ground gas within the proposed structure. The site is not in an area where radon gas is at levels of concern. A low or negligible risk from ground gas is concluded.
8. Routine excavation of soils in the soft landscaped area will be unlikely but, unless the made ground is removed from the site, it is recommended that a 200 mm thick cover system is placed over the existing soils to reduce the potential exposure to end-users.

9. Construction workers are considered to be at ow risk but mitigation through the use of appropriate personal protection equipment and hygiene precautions should be adopted.
10. Providing that the mitigation is implemented in soft landscaped areas and the advice of an ecologist is sought with respect to the habitats within the pond, the site is considered to be suitable for the proposed use. If any suspected contaminated soil is encountered during construction this should be dealt with in accordance with duty of care.

B J Horne
BSc MSc FGS

Dr A F Howland
MSc PhD DIC CEng FIMMM CGeol FGS

A F HOWLAND ASSOCIATES
31 October 2017

APPENDIX A: REFERENCES

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APPENDIX B: EXPLORATORY HOLE RECORDS

Window sample hole records

Trial pit records

GW	Groundwater sa,ple
D	Small disturbed sample
ES	Environmental sample
L	Plastic liner
U	Nominal 70 mm diameter undisturbed open tube sample
SPT	Standard penetration test using a split spoon sampler. N Value is uncorrected, but the hammer energy ratio is given where known (in remarks).
IP xx	Initial penetration during the SPT recorded in millimetres. If initial penetration equals or exceeds 450 mm the test is aborted.
S x,x	SPT seating drive blow count given by the summation of the blows 'X' required to drive the seating length
T x,x,x,x	SPT test drive blow count 'N' given by the summation of the blows 'X' required to drive the seating length (300 mm)
X*Y	Incomplete standard penetration test where the seating/test drive could not be completed. The blows 'X' represent the total blows for the given length of seating drive 'Y' (mm)
dd/mm/yy: 1.0 **dd/mm/yy: dry**	Date, water level at the window sample hole depth at the end of shift and the start of the following shift

Each sample type is numbered sequentially with depth and relates to the depth range quoted

All depths and measurements are given in metres, except as noted

Strata descriptions compiled by visual examination of liner samples obtained after BS EN1997-2:2007 Eurocode 7 and its UK National Annex supported by BS 5930:2015 and modified in accordance with laboratory test results where applicable

A F Howland Associates
Geotechnical Engineers

Site	Number
Magellan Way, Spalding	WS01

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Tracked Window Sampling Rig, Dando Terrier 2002.	102mm to 2.00m 87mm to 3.00m	3.13	John Retchless	17.330
	Location 524344 E 321721 N	**Dates** 20/09/2017	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10-0.20	D1					MADE GROUND (Dark brown slightly clayey very gravelly fine to coarse sand. Frequent roots and rootlets to 0.1m. Gravel is subangular to subrounded fine to coarse brick, flint, tile, limestone, plastic, concrete and rare clinker)		
0.40-0.60	ES1							
0.40-0.60	ES2					...becoming clayey and with clay pockets		
0.70-0.80	D2							
					(1.70)			
1.20-1.50	D3							
1.20-2.00	L1							
1.30	GW1							▼1
1.70-1.89	D4		Fast / Slow(1) at 1.70m, rose to 1.30m in 20 mins, not sealed.	1.43	1.70			▽1
					(0.19)	MADE GROUND (Very soft black sandy gravelly very organic clay. Gravel is subangular to subrounded fine to coarse timber, organic fragments and plastic bag. Organic odour. Former pond base/sediment)		
1.90-2.00	D5			1.24	1.89			
2.00-2.65	SPT	1.33	IP 200/S 1,3			Very soft brown mottled black silty slightly sandy organic CLAY. With rootlets. Organic odour		
2.00-2.30	D7				(0.47)			
2.00-2.45	D6							
2.00-3.00	L2							
	N=12		T 3,3,3,3	0.77	2.36			
2.40-2.60	D8					Grey slightly clayey sandy SILT. Organic odour		
2.60-3.00	D9					...tending to a grey silty fine to medium SAND		
					(0.64)			
			20/09/2017:1.31m	0.13	3.00	Complete at 3.00m		

Remarks
1. Location CAT scanned prior to excavation.
2. Hand dug inspection pit to 1.20 m.
3. Groundwater struck at 1.70 m and rose to 1.35 m in 5 mins., 1.34 m in 10 mins., 1.32 m in 15 mins. and 1.30 m in 20 mins.
4. SPT Hammer Energy Ratio = 70.73%
5. Position backfilled with arisings upon completion

Scale (approx)	Logged By
1:25	DJM

Figure No.
17.330.WS01

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A F Howland Associates
Geotechnical Engineers

Site	Number
Magellan Way, Spalding	WS02

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Tracked Window Sampling Rig, Dando Terrier 2002.	102mm to 2.00m 87mm to 3.00m 75mm to 4.00m	3.79	John Retchless	17.330
	Location 524342 E 321727 N	**Dates** 20/09/2017	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1				(0.32)	MADE GROUND (Dark brown slightly gravelly fine to coarse sand. Gravel is subangular to subrounded fine to coarse clinker, ask, flint, brick, concrete, metal and plastic) ...becoming layered black, grey, orange, evidence of burning/ash layers		
0.20-0.30	ES1			3.47	0.32			
0.35-0.45	D2				(0.44)	MADE GROUND (Brown gravelly fine to coarse sand. Gravel is subangular to subrounded fine to coarse brick, clinker. Frequent whole bricks) ...metal bar protruding from sidewall of pit ...becoming with cement board [possible asbestos containing material]		
0.60	D3							
0.60	D4							
0.60	ES2			3.03	0.76			
0.80-0.90	D5					MADE GROUND (Dark brown mottled black and orange brown, ashy slightly clayey gravelly fine to coarse sand. Gravel is subangular to subrounded fine to coarse charred timber, tile, plastic, metal, timber, concrete)		
0.90	ES3							
1.20-1.60	D6							
1.20-2.00	L1				(1.74)			▼1
			Moderate(1) at 1.90m, rose to 1.72m in 20 mins, not sealed.					▽1
2.00-3.00	L2							
				1.29	2.50	[Poor liner recovery due to timber fragment. Exact level of strata change unclear] Light grey silty fine to medium SAND. Organic odour		
2.85-2.90	D7							
2.90-3.00	D8							
3.00-4.00	D9							
3.00-4.00	L3				(1.50)			
			20/09/2017:1.75m	-0.21	4.00	Complete at 4.00m		

Remarks
1. Location CAT scanned prior to excavation.
2. Hand dug inspection pit to 1.20 m.
3. Groundwater struck at 1.90 m and rose to 1.74 m in 5 mins. and 10 mins., 1.73 m in 15 mins. and 1.72 m in 20 mins.
4. Position backfilled with arisings upon completion

Scale (approx)	Logged By
1:25	DJM

Figure No.
17.330.WS02

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A F Howland Associates
Geotechnical Engineers

Site	Trial Pit Number
Magellan Way, Spalding	DP01-IP

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand dug inspection pit for DP01	L 0.3 m x W 0.3 m x D 1.2 m	3.59	John Retchless	17.330
	Location	**Dates**	**Engineer**	**Sheet**
	524344 E 321724 N	20/09/2017		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30 0.30-0.60	ES1 D1				(1.20)	MADE GROUND (Dark brown mottled orange brown and black slightly clayey slightly gravelly fine to coarse sand. Gravel is subangular to subrounded fine to coarse paper, brick, fliint, metal clinker and ash. Occasional whole bricks) ...0.35 m - pocket of semi-burnt paper		
0.80	ES2							
				2.39	1.20	Complete at 1.20m		

No image available

Remarks

1. Location CAT scanned prior to excavation.
2. No groundwater encountered
3. Trial Pit remained open and sidewalls stable during excavation
4. DP01 undertaken through base of the inspection pit
5. Inspection pit backfilled with arisings upon completion of DP01

Scale (approx)	Logged By	Figure No.
1:25	DJM	17.330.DP01-IP

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A F Howland Associates
Geotechnical Engineers

Site	Trial Pit Number
Magellan Way, Spalding	POND

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Hand dug sediment sampling from base of pond			John Retchless	17.330
	Location 524344 E 321715 N	**Dates** 20/09/2017	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00 0.00-0.20 0.00-0.30	GW1 ES1 B1				(0.30) 0.30	POND SEDIMENT (Dark brown slightly clayey sandy slightly gravelly organic silt. Organic/sulphurous odour. With frequent plant and organic material. Gravel is fine to coarse plastic, brick and flint) Complete at 0.30m		

No image available

Remarks

1. Pond sediment sampled
2. Pond water sample (GW1 - 0.0 m) taken from this position above sediment. Water had duck weed and slight oily sheen on surface, and was clear and light brown in colour. Organic odour.

Scale (approx)	Logged By	Figure No.
1:25	DJM	17.330.POND

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APPENDIX C: LABORATORY TESTING

Contamination Test Results

Sulphate and pH analysis

CONCEPT LIFE SCIENCES
DELIVERING SCIENCE

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Concept Life Sciences

Certificate of Analysis

3 Crittall Drive
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Tel : 01376 560120
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Report Number: 684810-2 AFHA

Date of Report: 06-Oct-2017

Customer: A F Howland Associates
The Old Exchange
Newmarket Road
Cringleford
Norwich
NR4 6UF

Customer Contact: Mr Daniel Myhill

Customer Job Reference: DJM/17.330/00/01
Customer Purchase Order: DJM/17.330/00/01
Customer Site Reference: Magellan Way, Spalding
Date Job Received at Concept: 25-Sep-2017
Date Analysis Started: 28-Sep-2017
Date Analysis Completed: 06-Oct-2017

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual

UKAS TESTING
1549

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Claire Brown Crociquia
Customer Service Manager

Issued by :
Claire Brown Crociquia
Customer Service Manager

Concept Reference: 684810
Project Site: Magellan Way, Spalding
Customer Reference: DJM/17.330/00/01

Soil Analysed as Soil
AFHA Soil Contamination 3

				Concept Reference	**684810 002**	**684810 003**	**684810 004**	**684810 008**	**684810 009**
				Customer Sample Reference	**DP01-1P ES1 @ 0.30m**	**Pond ES1 @ 0.00m**	**WS01 ES1 @ 0.40m**	**WS02 ES1 @ 0.20m**	**WS02 ES2 @ 0.60m**
				Date Sampled	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**
				Matrix Class	**Fill**	**Fill**	**Topsoil**	**Topsoil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Antimony	T257	A40	5	mg/kg	**12**	<5	<5	<5	<5
Arsenic	T257	A40	2.0	mg/kg	**23**	**6.9**	**13**	**18**	**13**
Beryllium	T245	A40	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	T257	A40	0.1	mg/kg	**88**	**2.0**	**0.3**	**130**	**49**
Chromium	T257	A40	0.5	mg/kg	**1100**	**15**	**21**	**35**	**22**
Copper	T257	A40	2	mg/kg	**58**	**65**	**37**	**94**	**50**
Lead	T257	A40	2	mg/kg	**6100**	**100**	**130**	**180**	**92**
Mercury	T245	A40	1.0	mg/kg	**1.6**	<1.0	<1.0	<1.0	<1.0
Nickel	T257	A40	0.5	mg/kg	**19**	**15**	**20**	**22**	**19**
Selenium	T257	A40	3	mg/kg	**9**	<3	<3	**8**	<3
Vanadium	T257	A40	0.1	mg/kg	**23**	**21**	**28**	**19**	**24**
Zinc	T257	A40	2	mg/kg	**240**	**670**	**100**	**550**	**230**
Asbestos ID	T27	A40			Asbestos not detected	-	Asbestos not detected	Asbestos not detected	Asbestos not detected
Organic Matter	T258	A40	0.5	%	**8.7**	**13**	**4.7**	**6.0**	**3.5**
Phosphate	T686	A40	1	mg/kg	**6**	<1	**1**	**6**	**4**
Chromium VI	T82	A40	1	mg/kg	<1	<1	<1	<1	<1
pH	T7	A40			**7.4**	**7.2**	**7.8**	**7.8**	**8.0**
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	**2.5**	**5.5**	**4.0**	**2.5**	**4.0**
Cyanide(Total)	T921	AR	1	mg/kg	<1	<1	<1	<1	<1
Phenols(Mono)	T921	AR	1	mg/kg	<1	**9**	<1	<1	<1
Moisture @105C	T162	AR	0.1	%	**17**	**78**	**15**	**19**	**16**
Retained on 2mm	T2	A40	0.1	%	<0.1	<0.1	**21.5**	**7.3**	**30.4**

Concept Reference: 684810
Project Site: Magellan Way, Spalding
Customer Reference: DJM/17.330/00/01

Soil Analysed as Soil
Total and Speciated USEPA16 PAH (SE) (MCERTS)

				Concept Reference	**684810 002**	**684810 003**	**684810 004**	**684810 008**	**684810 009**
				Customer Sample Reference	**DP01-1P ES1 @ 0.30m**	**Pond ES1 @ 0.00m**	**WS01 ES1 @ 0.40m**	**WS02 ES1 @ 0.20m**	**WS02 ES2 @ 0.60m**
				Date Sampled	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**
				Matrix Class	**Fill**	**Fill**	**Topsoil**	**Topsoil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T16	AR	0.1	mg/kg	**0.2**	<0.1	**0.2**	**0.2**	<0.1
Acenaphthylene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.1**	<0.1	<0.1
Acenaphthene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	T16	AR	0.1	mg/kg	<0.1	<0.1	**0.1**	<0.1	<0.1
Phenanthrene	T16	AR	0.1	mg/kg	**0.4**	**0.3**	**1.8**	**0.3**	<0.1
Anthracene	T16	AR	0.1	mg/kg	**0.1**	<0.1	**0.6**	<0.1	<0.1
Fluoranthene	T16	AR	0.1	mg/kg	**0.9**	**0.8**	**2.9**	**0.5**	<0.1
Pyrene	T16	AR	0.1	mg/kg	**0.8**	**0.7**	**2.4**	**0.4**	<0.1
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	**0.5**	**0.4**	**1.3**	**0.2**	<0.1
Chrysene	T16	AR	0.1	mg/kg	**0.6**	**0.5**	**1.3**	**0.3**	<0.1
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	**0.7**	**0.6**	**1.2**	**0.3**	<0.1
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	**0.5**	**0.3**	**1.0**	**0.3**	<0.1
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	**0.6**	**0.5**	**1.2**	**0.3**	<0.1
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	**0.4**	**0.3**	**0.6**	**0.2**	<0.1
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	**0.1**	**0.1**	**0.3**	<0.1	<0.1
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	**0.4**	**0.3**	**0.7**	**0.2**	<0.1
PAH(total)	T16	AR	0.1	mg/kg	**6.3**	**4.8**	**16**	**3.1**	<0.1

Concept Reference: 684810
Project Site: Magellan Way, Spalding
Customer Reference: DJM/17.330/00/01

Soil Analysed as Soil
TPH (CWG) with MTBE & BTEX SE

				Concept Reference	**684810 002**	**684810 003**	**684810 004**	**684810 008**	**684810 009**
				Customer Sample Reference	**DP01-1P ES1 @ 0.30m**	**Pond ES1 @ 0.00m**	**WS01 ES1 @ 0.40m**	**WS02 ES1 @ 0.20m**	**WS02 ES2 @ 0.60m**
				Date Sampled	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**	**20-SEP-2017**
				Matrix Class	**Fill**	**Fill**	**Topsoil**	**Topsoil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Benzene	T209	AR	10	µg/kg	<10	<10	<10	(13) **11**	<10
Toluene	T209	AR	10	µg/kg	<10	<10	<10	<10	<10
EthylBenzene	T209	AR	10	µg/kg	<10	<10	<10	<10	<10
M/P Xylene	T209	AR	10	µg/kg	<10	<10	<10	<10	<10
O Xylene	T209	AR	10	µg/kg	<10	<10	<10	<10	<10
Methyl tert-Butyl Ether	T209	AR	10	µg/kg	<10	<10	<10	<10	<10
TPH (C5-C6 aliphatic)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C6-C7 aromatic)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C6-C8 aliphatic)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C7-C8 aromatic)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C8-C10 aliphatic)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C8-C10 aromatic)	T54	AR	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
TPH (C10-C12 aliphatic)	T219	AR	2	mg/kg	<2	<2	<2	<2	<2
TPH (C10-C12 aromatic)	T219	AR	2	mg/kg	<2	<2	<2	<2	<2
TPH (C12-C16 aliphatic)	T219	AR	2	mg/kg	**2**	<2	<2	<2	<2
TPH (C12-C16 aromatic)	T219	AR	2	mg/kg	**3**	<2	**4**	**2**	<2
TPH (C16-C21 aliphatic)	T219	AR	2	mg/kg	**2**	<2	**3**	<2	**2**
TPH (C16-C21 aromatic)	T219	AR	2	mg/kg	**13**	**7**	**22**	**8**	<2
TPH (C21-C35 aliphatic)	T219	AR	2	mg/kg	**61**	**4**	**10**	**23**	**12**
TPH (C21-C35 aromatic)	T219	AR	2	mg/kg	**31**	**10**	**80**	**23**	**9**

Concept Reference: 684810
Project Site: Magellan Way, Spalding
Customer Reference: DJM/17.330/00/01

Water Analysed as Water
AFHA GROUNDWATER SUITE 3

				Concept Reference	**684810 012**
				Customer Sample Reference	**Pond GW1 @ 0.00m**
				Date Sampled	**20-SEP-2017**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**	
Sb (Dissolved)	T281	F	1	µg/l	**1**
As (Dissolved)	T281	F	0.2	µg/l	**0.9**
Be (Dissolved)	T281	F	0.05	µg/l	<0.05
Cd (Dissolved)	T281	F	0.02	µg/l	<0.02
Cr (Dissolved)	T281	F	1	µg/l	<1
Cu (Dissolved)	T281	F	0.5	µg/l	**1.4**
Pb (Dissolved)	T281	F	0.3	µg/l	**0.4**
Hg (Dissolved)	T281	F	0.05	µg/l	<0.05
Ni (Dissolved)	T281	F	1	µg/l	<1
Se (Dissolved)	T281	F	0.5	µg/l	<0.5
V (Dissolved)	T281	F	2	µg/l	<2
Zn (Dissolved)	T281	F	2	µg/l	**8**
Ammoniacal nitrogen	T686	F	50	µg/l	**980**
Phosphate	T686	F	500	µg/l	**4800**
Chromium VI	T686	F	3	µg/l	(2) <30
pH	T7	F			**7.60**
Cyanide(Total)	T546	F	10	µg/l	<10
Phenols(Mono)	T546	F	20	µg/l	<20

Concept Reference: 684810
Project Site: Magellan Way, Spalding
Customer Reference: DJM/17.330/00/01

Water Analysed as Water
Total and Speciated USEPA16 PAH (SE)

Concept Reference	**684810 012**
Customer Sample Reference	**Pond GW1 @ 0.00m**
Date Sampled	**20-SEP-2017**

Determinand	Method	Test Sample	LOD	Units	
Naphthalene	T149	AR	0.01	µg/l	**0.03**
Acenaphthylene	T149	AR	0.01	µg/l	<0.01
Acenaphthene	T149	AR	0.01	µg/l	<0.01
Fluorene	T149	AR	0.01	µg/l	<0.01
Phenanthrene	T149	AR	0.01	µg/l	**0.06**
Anthracene	T149	AR	0.01	µg/l	<0.01
Fluoranthene	T149	AR	0.01	µg/l	<0.01
Pyrene	T149	AR	0.01	µg/l	**0.05**
Benzo(a)Anthracene	T149	AR	0.01	µg/l	<0.01
Chrysene	T149	AR	0.01	µg/l	<0.01
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	<0.01
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	<0.01
Benzo(a)Pyrene	T149	AR	0.01	µg/l	<0.01
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	<0.01
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	<0.01
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	<0.01
PAH(total)	T149	AR	0.01	µg/l	**0.14**

Concept Reference: 684810
Project Site: Magellan Way, Spalding
Customer Reference: DJM/17.330/00/01

Water Analysed as Water
TPH (CWG) with MTBE & BTEX SE

Concept Reference	**684810 012**
Customer Sample Reference	**Pond GW1 @ 0.00m**
Date Sampled	**20-SEP-2017**

Determinand	Method	Test Sample	LOD	Units	
Benzene	T54	AR	1	µg/l	<1
EthylBenzene	T54	AR	1	µg/l	<1
M/P Xylene	T54	AR	1	µg/l	<1
O Xylene	T54	AR	1	µg/l	<1
Toluene	T54	AR	1	µg/l	<1
Methyl tert-Butyl Ether	T54	AR	1	µg/l	<1
TPH (C5-C6 aliphatic)	T54	AR	20	µg/l	<20
TPH (C6-C7 aromatic)	T54	AR	20	µg/l	<20
TPH (C6-C8 aliphatic)	T54	AR	20	µg/l	<20
TPH (C7-C8 aromatic)	T54	AR	20	µg/l	<20
TPH (C8-C10 aliphatic)	T54	AR	20	µg/l	<20
TPH (C8-C10 aromatic)	T54	AR	20	µg/l	<20
TPH (C10-C12 aliphatic)	T219	AR	10	µg/l	**22**
TPH (C10-C12 aromatic)	T219	AR	10	µg/l	**18**
TPH (C12-C16 aliphatic)	T219	AR	10	µg/l	**30**
TPH (C12-C16 aromatic)	T219	AR	10	µg/l	**48**
TPH (C16-C21 aliphatic)	T219	AR	10	µg/l	**80**
TPH (C16-C21 aromatic)	T219	AR	10	µg/l	**150**
TPH (C21-C35 aliphatic)	T219	AR	10	µg/l	**36**
TPH (C21-C35 aromatic)	T219	AR	10	µg/l	**150**

Index to symbols used in 684810-2 AFHA

Value	Description
F	Filtered
AR	As Received
10:1	Leachate to BS EN 12457-2 (10:1)

A40	Assisted dried < 40C
13	Results have been blank corrected.
2	LOD Raised Due to Matrix Interference
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis except TPH c5-c35 aromatic/aliphatic split & Ammonia
Asbestos subcontracted to REC Limited
Retained on 2mm is removed before analysis

Method Index

Value	Description
T281	ICP/MS (Filtered)
T4	Colorimetry
T546	Colorimetry (CF)
T7	Probe
T257	ICP/OES (SIM) (Aqua Regia Extraction)
T162	Grav (1 Dec) (105 C)
T258	Titration (Dichromate)
T219	GC/FID (SE)
T921	Colorimetry (CF) (MCERT)
T245	ICP/OES (Aqua Regia Extraction)
T16	GC/MS
T27	PLM
T82	ICP/OES (Sim)
T149	GC/MS (SIR)
T209	GC/MS (Head Space)(MCERTS)
T686	Discrete Analyser
T54	GC/MS (Headspace)
T2	Grav

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Naphthalene	T16	AR	0.1	mg/kg	U	002-004,008-009
Acenaphthylene	T16	AR	0.1	mg/kg	U	002-004,008-009
Acenaphthene	T16	AR	0.1	mg/kg	U	002-003
Acenaphthene	T16	AR	0.1	mg/kg	M	004,008-009
Fluorene	T16	AR	0.1	mg/kg	U	002-003
Fluorene	T16	AR	0.1	mg/kg	M	004,008-009
Phenanthrene	T16	AR	0.1	mg/kg	U	002-004,008-009
Anthracene	T16	AR	0.1	mg/kg	U	002-003
Anthracene	T16	AR	0.1	mg/kg	M	004,008-009
Fluoranthene	T16	AR	0.1	mg/kg	N	002-004,008-009
Pyrene	T16	AR	0.1	mg/kg	N	002-004,008-009
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	U	002-003
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	M	004,008-009
Chrysene	T16	AR	0.1	mg/kg	U	002-003
Chrysene	T16	AR	0.1	mg/kg	M	004,008-009
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	U	002-004,008-009
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	N	002-004,008-009
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	U	002-003
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	M	004,008-009
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	U	002-003
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	M	004,008-009
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	U	002-003
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	M	004,008-009
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	U	002-003
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	M	004,008-009
PAH(total)	T16	AR	0.1	mg/kg	U	002-004,008-009
Sb (Dissolved)	T281	F	1	µg/l	U	012
As (Dissolved)	T281	F	0.2	µg/l	U	012
Be (Dissolved)	T281	F	0.05	µg/l	U	012

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Cd (Dissolved)	T281	F	0.02	µg/l	U	012
Cr (Dissolved)	T281	F	1	µg/l	U	012
Cu (Dissolved)	T281	F	0.5	µg/l	U	012
Pb (Dissolved)	T281	F	0.3	µg/l	U	012
Hg (Dissolved)	T281	F	0.05	µg/l	U	012
Ni (Dissolved)	T281	F	1	µg/l	U	012
Se (Dissolved)	T281	F	0.5	µg/l	U	012
V (Dissolved)	T281	F	2	µg/l	U	012
Zn (Dissolved)	T281	F	2	µg/l	U	012
Ammoniacal nitrogen	T686	F	50	µg/l	U	012
Phosphate	T686	F	500	µg/l	U	012
Chromium VI	T686	F	3	µg/l	U	012
pH	T7	F			U	012
Cyanide(Total)	T546	F	10	µg/l	U	012
Phenols(Mono)	T546	F	20	µg/l	U	012
Naphthalene	T149	AR	0.01	µg/l	U	012
Acenaphthylene	T149	AR	0.01	µg/l	U	012
Acenaphthene	T149	AR	0.01	µg/l	U	012
Fluorene	T149	AR	0.01	µg/l	U	012
Phenanthrene	T149	AR	0.01	µg/l	U	012
Anthracene	T149	AR	0.01	µg/l	U	012
Fluoranthene	T149	AR	0.01	µg/l	U	012
Pyrene	T149	AR	0.01	µg/l	U	012
Benzo(a)Anthracene	T149	AR	0.01	µg/l	U	012
Chrysene	T149	AR	0.01	µg/l	U	012
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	N	012
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	U	012
Benzo(a)Pyrene	T149	AR	0.01	µg/l	U	012
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	U	012
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	U	012
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	U	012
PAH(total)	T149	AR	0.01	µg/l	N	012
Benzene	T54	AR	1	µg/l	U	012
EthylBenzene	T54	AR	1	µg/l	U	012
M/P Xylene	T54	AR	1	µg/l	U	012
O Xylene	T54	AR	1	µg/l	U	012
Toluene	T54	AR	1	µg/l	U	012
Methyl tert-Butyl Ether	T54	AR	1	µg/l	U	012
TPH (C5-C6 aliphatic)	T54	AR	20	µg/l	N	012
TPH (C6-C7 aromatic)	T54	AR	20	µg/l	N	012
TPH (C6-C8 aliphatic)	T54	AR	20	µg/l	N	012
TPH (C7-C8 aromatic)	T54	AR	20	µg/l	N	012
TPH (C8-C10 aliphatic)	T54	AR	20	µg/l	N	012
TPH (C8-C10 aromatic)	T54	AR	20	µg/l	N	012
TPH (C10-C12 aliphatic)	T219	AR	10	µg/l	N	012
TPH (C10-C12 aromatic)	T219	AR	10	µg/l	N	012
TPH (C12-C16 aliphatic)	T219	AR	10	µg/l	N	012
TPH (C12-C16 aromatic)	T219	AR	10	µg/l	N	012
TPH (C16-C21 aliphatic)	T219	AR	10	µg/l	N	012
TPH (C16-C21 aromatic)	T219	AR	10	µg/l	N	012
TPH (C21-C35 aliphatic)	T219	AR	10	µg/l	N	012
TPH (C21-C35 aromatic)	T219	AR	10	µg/l	N	012
Antimony	T257	A40	5	mg/kg	N	002-004,008-009
Arsenic	T257	A40	2.0	mg/kg	U	002-003
Arsenic	T257	A40	2	mg/kg	M	004,008-009
Beryllium	T245	A40	1	mg/kg	U	002-004,008-009
Cadmium	T257	A40	0.1	mg/kg	U	002-003
Cadmium	T257	A40	0.1	mg/kg	M	004,008-009
Chromium	T257	A40	0.5	mg/kg	U	002-003
Chromium	T257	A40	0.5	mg/kg	M	004,008-009
Copper	T257	A40	2	mg/kg	U	002-003
Copper	T257	A40	2	mg/kg	M	004,008-009
Lead	T257	A40	2	mg/kg	U	002-003
Lead	T257	A40	2	mg/kg	M	004,008-009
Mercury	T245	A40	1.0	mg/kg	U	002-004,008-009
Nickel	T257	A40	0.5	mg/kg	U	002-003
Nickel	T257	A40	0.5	mg/kg	M	004,008-009
Selenium	T257	A40	3	mg/kg	U	002-004,008-009
Vanadium	T257	A40	0.1	mg/kg	U	002-004,008-009
Zinc	T257	A40	2	mg/kg	U	002-003

Determinand	Method	Test Sample	LOD	Units	Symbol	Concept References
Zinc	T257	A40	2	mg/kg	M	004,008-009
Asbestos ID	T27	A40			SU	002,004,008-009
Organic Matter	T258	A40	0.5	%	N	002-004,008-009
Phosphate	T686	A40	1	mg/kg	N	002-004,008-009
Chromium VI	T82	A40	1	mg/kg	N	002-004,008-009
pH	T7	A40			U	002-003
pH	T7	A40			M	004,008-009
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	N	002-004,008-009
Cyanide(Total)	T921	AR	1	mg/kg	U	002-003
Cyanide(Total)	T921	AR	1	mg/kg	M	004,008-009
Phenols(Mono)	T921	AR	1	mg/kg	U	002-003
Phenols(Mono)	T921	AR	1	mg/kg	M	004,008-009
Moisture @105C	T162	AR	0.1	%	N	002-004,008-009
Retained on 2mm	T2	A40	0.1	%	N	002-004,008-009
Benzene	T209	AR	10	µg/kg	U	002-003
Benzene	T209	AR	10	µg/kg	M	004,008-009
Toluene	T209	AR	10	µg/kg	U	002-003
Toluene	T209	AR	10	µg/kg	M	004,008-009
EthylBenzene	T209	AR	10	µg/kg	U	002-003
EthylBenzene	T209	AR	10	µg/kg	M	004,008-009
M/P Xylene	T209	AR	10	µg/kg	U	002-003
M/P Xylene	T209	AR	10	µg/kg	M	004,008-009
O Xylene	T209	AR	10	µg/kg	U	002-003
O Xylene	T209	AR	10	µg/kg	M	004,008-009
Methyl tert-Butyl Ether	T209	AR	10	µg/kg	U	002-003
Methyl tert-Butyl Ether	T209	AR	10	µg/kg	M	004,008-009
TPH (C5-C6 aliphatic)	T54	AR	0.10	mg/kg	N	002-004,008-009
TPH (C6-C7 aromatic)	T54	AR	0.10	mg/kg	N	002-004,008-009
TPH (C6-C8 aliphatic)	T54	AR	0.10	mg/kg	N	002-004,008-009
TPH (C7-C8 aromatic)	T54	AR	0.10	mg/kg	N	002-004,008-009
TPH (C8-C10 aliphatic)	T54	AR	0.10	mg/kg	N	002-004,008-009
TPH (C8-C10 aromatic)	T54	AR	0.10	mg/kg	N	002-004,008-009
TPH (C10-C12 aliphatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C10-C12 aromatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C12-C16 aliphatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C12-C16 aromatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C16-C21 aliphatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C16-C21 aromatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C21-C35 aliphatic)	T219	AR	2	mg/kg	N	002-004,008-009
TPH (C21-C35 aromatic)	T219	AR	2	mg/kg	N	002-004,008-009

A F Howland Associates
Geotechnical Engineers

Laboratory Test Results

Site : Magellan Way, Spalding

Client : John Retchless

Engineer :

Job Number 17.330

Sheet 1 / 1

DETERMINATION OF pH, SULPHATE CONTENT AND TOTAL SULPHUR OF SOIL AND GROUNDWATER

Borehole/ Trial Pit	Depth (m)	Sample	Concentration of Soluble Sulphate			Total Sulphur %	Percentage of sample passing 2mm Sieve %	pH	Classification	Laboratory Description
			Soil		Groundwater g /l					
			Total S04 %	S03 in 2:1 water:soil g /l						
DP01-1P	0.30	D1	0.15	0.08		0.07		7.7	DS-1	Fill
WS01	1.30	GW1			0.05			7.6	DS-1	Ground water sample
WS01	1.70	D4	1.50	2.90		2.70		7.2	DS-4	Fill
WS01	2.00	D7	0.12	0.33		0.15		7.8	DS-1	Clay
WS01	2.40	D8	0.16	0.52		0.32		7.7	DS-2	Sand
WS02	0.80	D5	0.24	0.46		0.10		8.1	DS-2	Sandy Soil

Method of Preparation : BS 1377:PART 1:1990:7.5 Preparation of soil for chemical tests BS 1377:PART 3:1990:5.2, 5.3, 5.4 & 9.4

Method of Test : Laboratory in-house methods based on BS1377: Part 3 for contents of water soluble sulphate, total sulphate and pH. Laboratory in-house method based on MEWAM (Environment Agency, 2006) for total sulphur

Remarks : Classification relates to Design Sulphate Class of BRE Special Digest 1 (2005)

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APPENDIX D: DRAWINGS

Drawing 17.330/PhaseII/1	Site Location Plan
Drawing 17.330/PhaseII/2	Exploratory Hole Location Plan
Drawing 3204.19 Rev.B	Parsons and Whittley – As Proposed



North

Circle indicates approximate location of site

Scale 1: 50,000 @ A4

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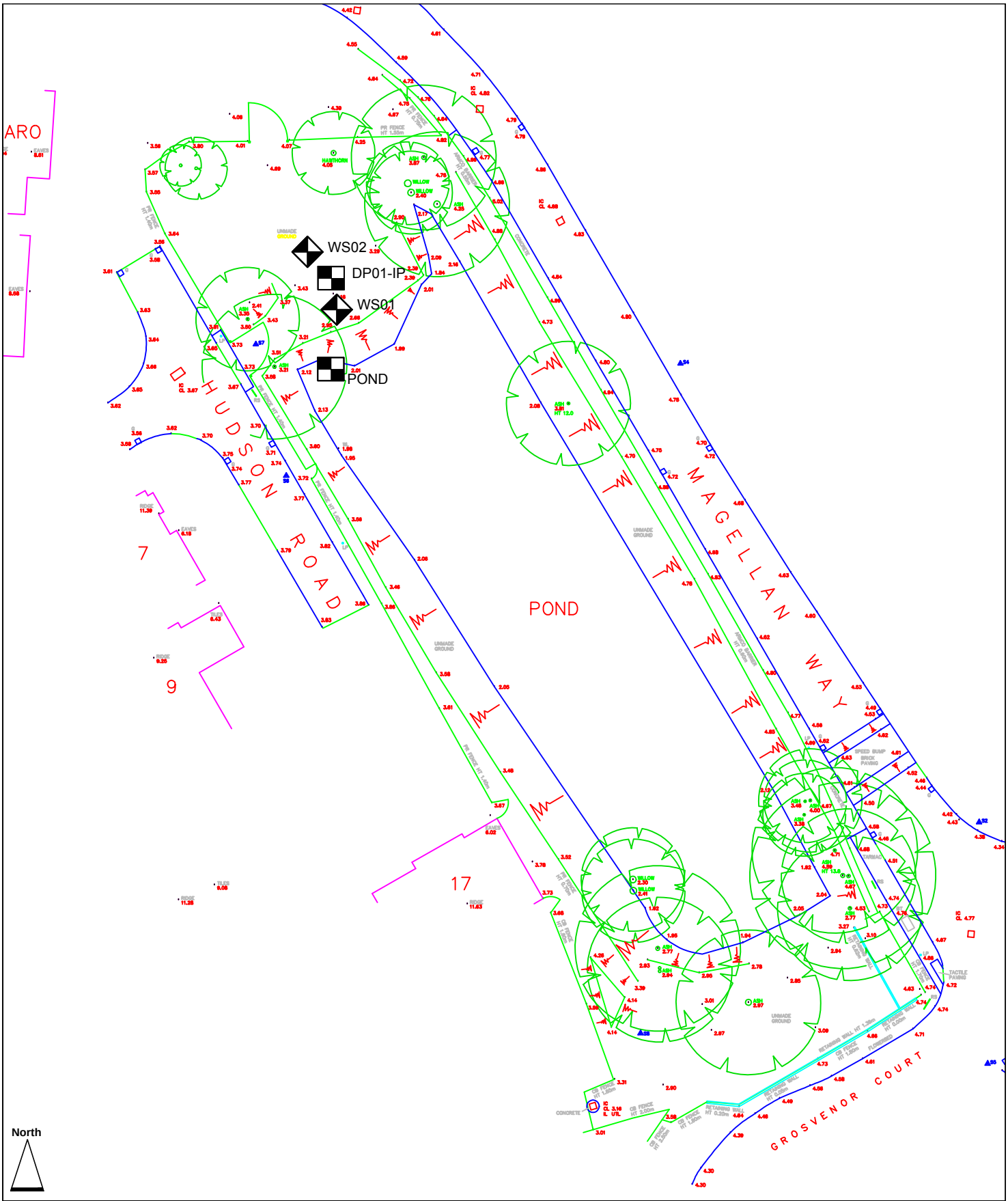
A F Howland Associates
Geotechnical Engineers

Site: Magellan Way, Spalding

SITE LOCATION PLAN

Client : John Retchless

Date : October 2017 **Dwg :** 17.330/PhaseII/1



Key:

Window sample location and reference

Trial pit location and reference

Based on East Anglian Land Surveys Ltd drawing 8835-1

A F Howland Associates
Geotechnical Engineers

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NR4 6UF

Tel: 01603 250754 Fax: 01603 250749

web: www.howland.co.uk
mail: admin@howland.co.uk

Client: John Retchless

Site: Magellan Way, Spalding

Job No.: 17.330

Drawing Title: EXPLORATORY HOLE LOCATION PLAN

Date: October 2017

Drawing No: 17.330/PhaseII/2

Scale: 1:500 @ A4

PARSONS + WHITTLEY



1:100 northern



1:100 eastern



1:100 southern



1:100 western

Materials:

Piles: Steel encased concrete supporting timber pile caps

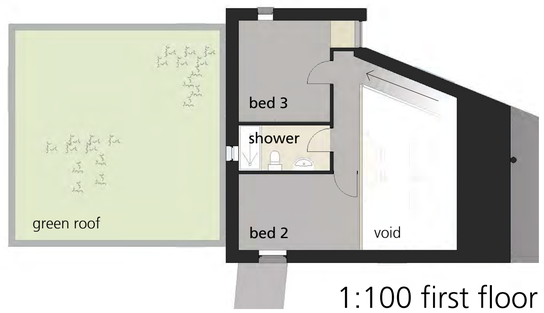
Walls: Vertical timber cladding, black flue pipe, charcoal-coloured rainwater goods

Roof: Profiled sheet cladding with PV panels, green roof over garage

Joinery: Charcoal-coloured metal-faced timber windows and doors, wire mesh and timber post balustrading to match existing fence, glazed balustrading to balcony



1:100 ground floor

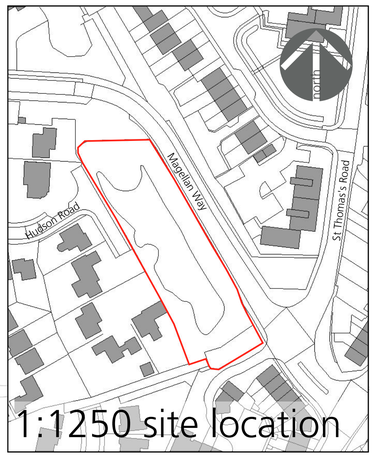


1:100 first floor

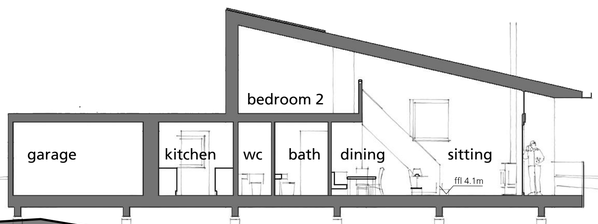
Gross Internal Floor Area:

Ground floor 74sqm, plus garage 29sqm
First Floor 29sqm

Total 103sqm plus garage 29sqm



1:1250 site location



pond level - varies seasonally

1:100 section



1:500 site plan

site area 2872sqm

Project:
Proposed Dwelling
Pond, off Magellan Way
Spalding

Client:
Mr & Mrs J Retchless

Title:
As Proposed

Revision Details:
design amended

Issue Date: 04-04-17

Parsons + Whittley Ltd Architects
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drawing number: **3204.19**
rev: **B**
size: **A1**

sheet **5**

RIBA Chartered Practice

This line measures 200mm in length when printed correctly

APPENDIX E: RISK ASSESSMENT CLASSIFICATION

Classification	Definition	Examples
Severe	Short term (acute) risk to human health. Short term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short term risk to a particular ecosystem, or organism forming part of such ecosystem.	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water.
Medium	Chronic damage to Human Health. Pollution of sensitive water resources. A significant change in a particular ecosystem, or organism forming part of such ecosystem.	Concentrations of a contaminant from site exceeds the generic, or site specific assessment criteria. Leaching of contaminants from a site to an aquifer.
Mild	Pollution of non-sensitive water resources. Significant damage to buildings/structures and crops ("significant harm" as defined in the Circular on Contaminated Land, DETR, 2000). Damage to sensitive buildings/structures or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as Personal Protective Clothing, etc). Easily repairable effects of damage to buildings/structures.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme.

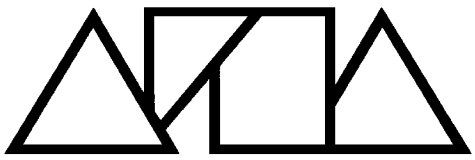
Classification of consequence

Classification	Definition
High Likelihood	There is a pollution linkage and an event which would either appear very likely in the short term and almost inevitable over the long term, or, there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term

Classification of probability

		CONSEQUENCE			
		Severe	Medium	Mild	Minor
PROBABILITY	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate/ Low Risk
	Likely	High Risk	Moderate Risk	Moderate/ Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/ Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/ Low Risk	Low Risk	Very Low Risk	Very Low Risk

Comparison of consequence against probability



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