

Report

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Reading Golf Club, Emmer Green
Flood Risk Assessment and Outline Sustainable Drainage Systems (SuDS) Strategy

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Executive summary

This report presents the findings of a Flood Risk Assessment and Outline SuDS Strategy for the proposed residential development at Reading Golf Course.

The Site is located in Flood Zone 1 and therefore has a Low Probability of flooding from rivers and the sea – this will also be true post-development after allowing for the expected effects of climate change. The Environment Agency's (EA's) Flood Map for Surface Water indicates that a surface water flow pathway runs along the northern part of the Site and appears to flow south west to north east, although this is only present under the extreme, 1 in 1000 year storm scenario.

The Site is currently 'greenfield' and as such the surface water runoff from the proposed development will need to be sustainably managed. This report presents an Outline SuDS Strategy for the management of surface water at the Site. The principal components of the scheme are three lined attenuation basins and a large infiltration basin in the north-eastern corner of the Site, along with the inclusion of swales and permeable paving in appropriate areas.

A preliminary assessment of the stormwater requirements for 1 in 100 year + 40% climate change storm was undertaken which shows that the proposed basins are capable of accommodating the required stormwater runoff volumes.

The Seaford Chalk underlying the northern part of the Site is considered an appropriate medium to receive infiltrating stormwater. This was confirmed during permeability tests at the Site. The overlying gravelly superficial deposits are also considered receptive media where the clay content is low.

The Outline SuDS Strategy will also intercept, attenuate, and divert the potential surface water flow pathway to remove flood risk to the Site and reduce flood risk downgradient.

1.0 Introduction

Yellow Sub Geo Ltd was instructed by Temple Group Ltd (Temple) on behalf of Fairfax Acquisitions Ltd (Fairfax) to undertake a Flood Risk Assessment (FRA) and Outline Sustainable Drainage Systems (SuDS) Strategy for the proposed residential development of Reading Golf Course, Kidmore End Road, Emmer Green, Reading, Berkshire, RG4 8SG ('the Site'). The work undertaken herein forms an update to the reporting and analysis undertaken by Stantec UK Ltd (Stantec) between 2019-2020.

This report has been produced in accordance with the National Planning Policy Framework (NPPF) and supporting Planning Practice Guidance (PPG). The NPPF and PPG require that flood risk is accounted for during all stages of the planning process to ensure that new development is appropriate for its location, will remain safe, and will not increase flood risk elsewhere.

1.1 Report objectives

This report presents the findings of an FRA and Outline SuDS Strategy for the Site that demonstrates that the proposed residential development meets the requirements of the NPPF and PPG.

1.2 Available information

This report is based on the following available information:

- Proposed development plan (Appendix A);
- Environment Agency (EA) Flood Map for Planning (Appendix B);
- EA Flood Map for Surface Water (Appendix C);
- EA Flood Map for Reservoirs (Appendix D);
- Reading Borough Council's Strategic Flood Risk Assessment (SFRA; PBA, 2017);
- Ordnance Survey mapping;
- Site specific data collected during a Site walkover by Stantec on 22nd February 2020;
- Open-source LiDAR Digital Terrain Model (DTM) data;
- British Geological Survey mapping; and
- Site specific geo-environmental assessment (Idom, 2019, Appendix G).
- Ground investigation report (Geo-Environmental Services Ltd, Appendix H).
- Supplementary ground investigation report (Geo-Environmental Services Ltd, Appendix H).

1.3 Report limitations

The findings presented in this report are primarily based on information supplied by third parties. Whilst Yellow Sub assumes that all information is representative of past and present conditions, we cannot guarantee its validity.

2.0 Site setting

2.1 Description of the existing Site

The Site is located in Emmer Green, c.1km north of Caversham in Reading and falls within the boundary of Reading Borough Council. The approximate National Grid Reference for the centre of the Site is SU 71527 76647 (Easting: 471657m; Northing: 176771m) with the closest postcode being RG4 8QZ.

The Site is currently a golf course (and, as such, is considered to be 'Greenfield' for the purposes of this FRA and SuDS report). The surface covering is principally grass with some trees, sand bunkers and footpaths with the main club house along Kidmore End Road in the south-east corner. The total Site area is 12 ha. It is important to note that the Site only includes approximately 50% of the existing golf course up to the County boundary.

2.2 Topography

The topography of the Site slopes from ca. 83m AOD along its southern boundary to ca. 73m AOD along its northern boundary. These gradients will dictate the flow pathways and discharge location point for any surface water runoff that the Site currently generates, which will gravitate towards a natural discharge point in the north-eastern corner of the Site (refer to coverage of the EA's Surface Water Flood Mapping – Appendix C).

2.3 Hydrology

The local area of the Site comprises dry valleys and as such there are no surface water features within at least 250m of the boundary of the Site.

2.4 Geology and Hydrogeology

2.4.1 Ground Investigation

The geology and hydrogeology at the Site have been characterised based on the findings of a series of ground investigation works undertaken at the Site between 2019 and 2021.

A Phase 1 (Non-intrusive Investigation) and a Phase 2a (Preliminary Exploratory Investigation) were initially undertaken by IDOM in 2019. A further preliminary investigation of the geo-technical and geo-environmental factors at the Site was undertaken by Geo-Environmental Services Ltd in 2020 (Geo-Environmental, 2020). A supplementary investigation to that completed in 2020 was undertaken by Geo-Environmental Services Ltd in 2021 (Geo-Environmental, 2021).

2.4.2 Geological and hydrogeological conditions

Cranfield University's Soilscales website (Cranfield University, 2020) provides high level information on soil characteristics across the UK. Soilscales classifies the soil at the Site as: '*Slightly acid loamy and clayey soils with impeded drainage*'. In-situ intrusive investigations undertaken at the Site, however, (Idom, 2019) describe the soil as brown loam with flint/chert gravel; this empirical description provides a more accurate account of the current soil properties.

Site investigation has proved that the Site comprises a succession of Black Park Gravel (sand and gravel, clay), Lambeth Group (sand and clay) and Seaford Chalk Formation. The Seaford Chalk Formation is defined by the EA as a Principal Aquifer and the Lambeth Group a Secondary Aquifer. The Seaford Chalk was typically encountered at depths of around 3m below ground level.

The Phase 1 investigations at the Site identified two areas at potential risk of ground stability associated with chalk dissolution. This included a 'medium' and 'high' risk zone for the presence of solution features extending across the north-western part of the Site, broadly where the Black Park Gravel and/or Lambeth Group thins out over the Chalk. These zones are shown on Figure 7.4. It should be noted that further geophysical surveys have not clearly identified the presence of solution features in this portion of the Site. However, taking a cautious approach at this stage in the development process, the outline drainage strategy (see Section 7.0) has been formulated taking account of these zones and the relevant design considerations.

The Site is located within a Zone 3 groundwater source protection zone (total catchment). A BGS borehole record for the borehole located at the Golf Club (106m north of the Site) gives a depth to groundwater in the Chalk of 37m in 1990 (Idom, 2019).

2.4.3 Permeability tests

Permeability tests were undertaken during the initial site investigation (Idom, 2019; Appendix F). Site investigation locations are included in Figure 7.4. These were conducted at various depths at three in-situ boreholes in the centre and northern half of the Site. The tests results are summarised in Table 1.

In general, the tests in the superficial deposits suggest little opportunity for disposal of water to ground (typically having a high clay content), although the geological logs indicate varying clay content around the site and the potential for infiltration will be greater in some areas than others. The Seaford Chalk underlying the northern portion of the Site has good infiltration potential.

Further trial pit soakage testing to BRE365 was undertaken by Geo-Environmental in April 2021. The results were broadly consistent with the previous permeability results, with the measured rates across the site ranging from 1.4×10^{-4} to 5.7×10^{-7} m/s.

Table 1 Permeability test results (Idom, 2019)

ID	Location	Geology	Permeability results (m/s)	Permeability results (m/h)
MBH1	Centre of the Site	Clay	10^{-8} or 10^{-9}	3.6^{-3} or 3.6^{-6}
MBH2	Eastern part of the Site	Hoggin (gravelly clay)	1.8×10^{-5} and 2.4×10^{-7}	0.0648 and 0.000864
MBH3	Northern part of the Site	Chalk	1.5×10^{-4} and 1.6×10^{-5}	0.54 and 0.058

2.4.4 Groundwater level monitoring

Spot groundwater level monitoring was undertaken in 5 wells across the Site by Geo Environmental Services Ltd between November 2020 and January 2021. The monitoring data indicates that, where encountered, groundwater levels range between 0.7 to 2.3 m below ground level in the southern and eastern part of the Site. In the north and north-east of the Site, the installed two piezometers (within the Black Park Gravel and Chalk) were dry to 3.5 to 4 m depth throughout the monitoring period.

2.5 Proposed development

The illustrative masterplan for the Site is provided in Appendix A. The proposal is for a residential development with green spaces, access roads and parking facilities. The development will contain 223 separate dwellings of varying sizes up to 5 bedroom detached houses with gardens and garages.

The private parking areas and minor roadways will be surfaced with permeable paving to reduce overall runoff and increase stormwater storage capacity. This is discussed further in Section 7.0.

3.0 Potential sources of flood risk

3.1 Flood Zones

The PPG defines three flood zones as shown in Table 2.

Table 2 PPG Flood Zones

Flood Zone	Return Period (Annual Exceedance Probability)
1	Low probability - less than 1 in 1,000 year (<0.1%) for river or sea flooding.
2	Medium probability - between 1 in 1,000 year (0.1%) and 1 in 100 year (1%) for river flooding or between 1 in 1,000 year (0.1%) and 1 in 200 year (0.5%) for sea flooding.
3a	High probability - 1 in 100 year (1%) or greater for river flooding or 1 in 200 year (0.5%) or greater for sea flooding.
3b	The Functional Floodplain - land where water has to flow or be stored in times of flood. There is not a strict definition of the annual probability of flooding in this zone, but the 1 in 20 year (5%) or greater return period should provide a starting point for consideration.

According to the EA's Flood Map for Planning (Appendix B), the Site is located in Flood Zone 1 (Low Probability). According to the NPPF/PPG, planning applications for sites greater than 1ha in Flood Zone 1 are required to be accompanied by an appropriate FRA.

3.2 Sources of flooding

Flooding can occur from a number of sources as shown in Table 3.

Table 3 Possible Sources of Flooding Identified in the PPG

Source	Description
Flooding from rivers	River flows which exceed the flow capacity of the river channel (or culverts) can cause flooding from rivers.
Flooding from the sea	High tides and/or storm surges can cause flooding from the sea.
Flooding from land	Intense rainfall that cannot soak into the ground or enter drainage systems can quickly run off the land and result in local flooding.
Flooding from groundwater	Groundwater flooding occurs when water levels in the ground rise above surface elevations.
Flooding from sewers	Sewer flooding can occur when piped systems are overwhelmed by heavy rainfall, when sewers become blocked or when sewers are of inadequate capacity.
Flooding from reservoirs, canals, and other artificial sources	Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes where water is retained above natural ground level.

4.0 Flood risk to the Site

4.1 Sources of flood risk data

The EA's Flood Maps shown in Appendix B, Appendix C and Appendix D provide a high level overview of the likely flood risk to a specific area or region, although do not account for the presence of existing flood defences or the likely impacts of climate change. Each of these sources of flood risk is considered in more detail below. Further details of modelled flood risk data, including allowances for climate change and defence assets, are included in the local Strategic Flood Risk Assessment (PBA, 2017).

4.2 Flooding from rivers and the sea

The EA's Flood Map for Planning (Appendix B) indicates that the proposed development is located in Flood Zone 1, and as such has a Low Probability of flooding from rivers and the sea (i.e. less than a 0.1% annual probability of flooding from these sources). As such, the risk to the proposed development from flooding from rivers or the sea is not considered further. The Site is not protected by any flood defences (PBA, 2017).

4.3 Flooding from surface water

The EA's Flood Map for Surface Water (Appendix C) indicates that a surface water flow pathway runs through the northern part of the Site. This surface water flow pathway conveys overland flow from off-site areas (i.e. the existing residential area to the west of the Site) in a south-west to a north-easterly direction through the northern portion of the Site to a downstream discharge point to the east of Cucumber Wood (Appendix C). This flow path is only shown to be present during 'Low Risk' events (i.e. surface water flooding events with an annual probability of occurring of between 1% and 0.1%).

The Outline SuDS Strategy for the proposed development (see Section 7.0) has been designed to a) discharge all surface water runoff generated by the proposed development to ground for events up to the 1% (plus climate change) probability; and b) intercept and divert the off-site runoff that contributes to this flow pathway during 'Low Risk' events of between the 1% and 0.1% probability. As such, with the proposed development in place, this surface water flow pathway will be reduced in extent and diverted to avoid the residential properties, although would still retain its existing discharge point to the east of Cucumber Wood.

4.4 Flooding from groundwater

Groundwater monitoring indicates that levels are shallow in the central and eastern parts of the Site. The groundwater encountered is understood to be localised and discontinuous perched layers and is not representative of a continuous or regional water table. Groundwater within the bedrock beneath the Site is thought to be much deeper below the surface.

Based on the above, it is unlikely that significant groundwater reserves are present beneath the Site at elevations close enough to existing ground levels to present a potential risk of groundwater flooding. In addition, the Site is located in the headwaters of a surface water catchment and bounded to the south by a ridge-like landform. Any potential groundwater emergence would, therefore, be expected to follow a similar route to the overland flow pathway discussed above towards the bottom

of the valley just to the north of Cucumber Wood. Accordingly, this source of flood risk is not considered further.

4.5 Flooding from sewers

The SFRA for the Site states that sewer flooding has occurred historically on Kidmore End Road c. 250 m east of the Site (based on SFRA historical flood mapping).

The Outline SuDS Strategy for the proposed development (see Section 7.0) has been designed to safely convey and discharge all surface water runoff generated by the proposed development to ground for events up to the 1% (plus climate change) probability. As such, the risk of sewer flooding to the proposed development is not considered further.

4.6 Flooding from reservoirs, canals and other artificial sources

There are no historical records of flooding of the Site from reservoir failure, canals or other artificial sources. Reservoir flooding is unlikely to happen, although the EA has produced flood mapping to indicate the worst-case scenario in the event of reservoir failure. The EA's Flood Map for Reservoirs (Appendix D) indicates that the Site would not be at risk of reservoir flooding. Accordingly, these sources of flood risk are not considered further.

4.7 Climate change

Results of flood risk modelling, including the likely impacts of climate change are included in the local SFRA (PBA, 2017). This report indicates that the Site will remain within Flood Zone 1 in the future after allowing for climate change uplifts.

5.0 Planning practice guidance

5.1 Proposed land use classification

The proposed residential development is classified as a '*More Vulnerable*' land use, which is defined under the PPG as: "*Buildings used for dwelling houses...*". According to the PPG, this would mean that the proposed development is considered appropriate for location within Flood Zone 1.

5.2 Sequential Test

The PPG Sequential Test aims to steer new development to areas that have the lowest probability of flooding. Given that the proposed development is located within Flood Zone 1 (Low Probability), the Sequential Test is considered to be passed (notwithstanding the need for the proposed development to manage the surface water flow pathway as mentioned in Section 4.3 above and Section 0 below, and provide an appropriate SuDS Strategy).

6.0 Flood risk considerations

6.1 Key considerations

To meet (or exceed) the PPG requirements, '*More Vulnerable*' residential land use such as that proposed at the Site will be considered suitable for location within Flood Zone 1 provided it:

- Remains safe in times of surface (or groundwater) flooding whilst taking climate change into account;
- Does not result in a net loss of floodplain storage;
- Does not impede existing surface water flow pathways; and
- Does not increase the volume and rate of surface water runoff leaving the Site over its intended design lifetime.

Each of these requirements is discussed in relation to the proposed development in Sections 6.2 to 6.4 below.

6.2 Remain safe in times of flooding

The Site is not considered to be at significant risk of flooding from rivers, groundwater or the sea, although this FRA has given due consideration to the potential surface water flow pathway that could cross the northern part of the Site during 'Low Risk' events of between the 1% and 0.1% probability (see Section 4.3 above).

The Outline SuDS Strategy for the proposed development (see Section 7.0) will a) discharge all surface water runoff generated by the proposed development to ground for events up to the 1% (plus climate change) probability; and b) intercept and divert the off-Site runoff that contributes to this flow pathway during 'Low Risk' events (see Section 0). The surface water flow pathway will, therefore, be reduced in extent and diverted to avoid the residential properties, although would still retain its existing discharge point to the east of Cucumber Wood. As such, with these measures in place, the proposed development would be safe for its users over its intended design lifetime.

6.3 No net loss of floodplain storage

The proposed development would not result in a net loss of river floodplain storage as the Site is not shown to be at a significant risk of flooding from rivers (see Appendix B).

6.4 No impediment to flood water flows

As described above and in Section 0 below, the proposed development will enable the surface water flow pathway to retain its existing discharge point to the east of Cucumber Wood and, as such, will not result in an impediment to surface water flood flows.

7.0 Outline Sustainable Drainage Systems (SuDS) Strategy

7.1 Introduction

The following sections describe the Outline SuDS Strategy for the proposed development with due regard to DEFRA's Non-statutory technical standards for SuDS (DEFRA, 2015), which recommends the following hierarchy for the disposal of surface water from new developments:

- 1) Discharge to ground via infiltration techniques (most preferred);
- 2) Discharge to a surface water body;
- 3) Discharge to a surface water sewer;
- 4) Discharge to a local highway drain; and
- 5) Discharge to a combined sewer (least preferred).

The proposed residential development will be located on previously undeveloped, 'greenfield' land. A significant proportion of the Site would comprise impermeable area following its development (for example, roofs, roads, and car parking areas). Without appropriate management, this would result in a significant increase in both the volume and rate of surface runoff generated by the proposed development, which could lead to an increase in surface water flood risk elsewhere (i.e. downstream). Surface runoff from the developed site will, however, be sustainably managed using SuDS, as described in the following sections.

7.2 Runoff destination

The Seaford Chalk underlying the northern half of the Site is sufficiently permeable to allow surface water from the proposed development to be discharged to ground using infiltration techniques, as are the gravelly superficial deposits present where the clay content is not high.

As such, surface water from the proposed development will discharge via gravity to three attenuation basins, discharging to an infiltration basin in the north-eastern corner of the Site. The infiltration basin will discharge to the Seaford Chalk encountered at a depth of 2m to 3m at the location of the basin. The attenuation basins are proposed to be lined. Piezometers indicates that groundwater is at least 3.5 m below the surface in this area.

The basins are herein referred to as Basins 1, 2, 3 and 4 respectively (see Figure 7.1 for the location of these basins). The proposed development layout has been sub-divided into four catchments that will each drain via gravity to one of these basins, with a final discharge to the infiltration basin (see Figure 7.1). These sub-catchments have been delineated based on the development layout plan included in Appendix A and LiDAR Digital Terrain Model (DTM) data.

The Site will require some raising and lowering of existing ground levels to achieve the required cover depths and gradients for an adoptable surface water drainage system (locations are shown on Figure 7.2). It is anticipated that in-situ arisings from the excavation of the basins and the construction of house foundations would be used for this purpose, without the requirement to import significant volumes of external fill material.

7.3 Greenfield runoff estimation and discharge rates

The Institute of Hydrology Report 124 (IH124) method in the 'Rural Runoff' calculator within MicroDrainage was utilised to estimate the greenfield runoff rates for the existing Site area. The calculation was carried out for an assumed site area of 50ha, with the rate then pro-rated for the actual Site area (12ha) (as recommended in the Interim Code of Practice for SuDS Design and Environment Agency/DEFRA Report: Preliminary Rainfall-Runoff Management for Developments (DEFRA, 2015)). The 'QBAR' (i.e. 1 in 2 year return period) greenfield runoff rate for the existing Site was thus determined along with runoff rates for other return period storm using the regional growth curve (see Table 4).

Table 4 Greenfield runoff rates

Storm return period (yrs)	Runoff rate (l/s)	Runoff rate (l/s/ha)
1	3.9	0.32
2 (Qbar)	4.6	0.38
30	10.4	0.86
100	14.7	1.22

The QBAR greenfield runoff rate was used to determine the 'permissible discharge' rates for the Site. Current industry guidance recommends that the minimum permissible discharge rate for any single point of discharge is 5 l/s (i.e. to minimise the risk of blockage of flow control devices designed to achieve lower rates). The QBAR greenfield runoff rate yielded 'permissible discharge' rate that was lower than 5 l/s. As such, a 5 l/s 'permissible discharge' rate has been assumed for the discharge from attenuation basins to the infiltration basin.

7.4 Contributing areas

GIS software was used to calculate the total impermeable area (i.e. roofs, roads and hardstanding pedestrian walkways) proposed within the sub-catchment draining to each infiltration basin (see Table 5 below).

For the purposes of the runoff calculations, the areas of permeable paving were subtracted from each overall catchment area (i.e. it was assumed that these areas would not generate surface runoff). This was considered a reasonable approach given that a) permeable paving systems can accommodate high rainfall intensities; b) the granular sub-grade fill beneath the paving units would provide attenuation storage; and c) some infiltration to ground would be possible beneath the sub-grade, although the rate of which is expected to vary across the site.

Table 5 Proposed impermeable and permeable areas

Catchment and Basin	Impermeable area (ha)*	Residual permeable area (ha)	Total (ha)
A, Basin 1	0.73	1.78	2.51
B, Basin 2	0.87	1.40	2.27
C, Basin 3	0.39	1.03	1.42
D, Basin 4	1.53	4.20	5.73
Total	3.52	8.41	11.93

* Includes 10% uplift for urban creep.

The impermeable areas in Table 5 were uplifted by 10% to account for urban creep (e.g. the conversion of private gardens to paved areas) over the lifetime of the proposed development, as per the current guidance for drainage design.

7.5 Stormwater storage and infiltration design

A preliminary sizing assessment of the attenuation basins and infiltration basin has been undertaken using the Storage Estimate tool within the Causeway Flow drainage design software. The tool was run for the 1 in 100-year event plus a 40% allowance for climate change for each of the respective catchments/ basins. The stormwater storage requirements and basin dimensions are presented in Table 6. The basin footprints were measured from the proposed development layout in Appendix A. Outputs from the storage estimate tool are provided in Appendix E.

The infiltration rate for the proposed infiltration basin was estimated based on the nearest site investigation data (see MBH3 - Table 1). Permeability results for the Seaford Chalk underlying the proposed location of the infiltration basin were 1.5×10^{-4} and 1.6×10^{-5} m/s (0.54 and 0.058 m/hr). The lower of the two measured rates (1.6×10^{-5} m/s) was used to undertake a preliminary sizing of the infiltration basin. The permissible discharge rate of 5 l/s was used in sizing the attenuation basins.

The storage requirements for each basin are presented in Appendix E as an estimated minimum and maximum, based on FEH2013 rainfall parameters and all storm durations (15 to 10,080mins). For conservatism, the maximum value is presented in Table 6. It has been assumed that all basins will have maximum 1:3 internal side slopes.

Table 6 Storage requirements and Basin dimensions

Feature	Max. Stormwater storage required (m ³)	Discharge/infiltration rate	Basin Depth (m) inc. freeboard	Area of top (at bank) (m ²)	Basin Capacity (m ³)
Basin 1 (Attenuation Basin)	1,047	5 l/s	2.5	775	1,235
Basin 2 (Attenuation Basin)	1,338	5 l/s	2.3	1,015	1,505
Basin 3 (Attenuation Basin)	423	5 l/s	1.3	705	655
Basin 4 (Infiltration Basin)	1,598	1.6 x 10 ⁻⁵ m/s	3.0	1,775	3,690
Total (Basins 1-4)*	(3,676)	(0.0576 m/hr)			

* Storage requirement for proposed total impermeable area (3.52ha – see Table 5), assuming minimum infiltration rate to Seaford Chalk of 1.6 x 10⁻⁵ m/s.

An outline drainage network was drafted based upon the proposed development layout and the current site topography (see Figure 7.2). Indicative key manhole locations are included in Figure 7.2 along with current ground levels at each location (extracted from LiDAR data); these highlight areas where raising or lowering of ground will be required to produce an adoptable drainage system.

Connecting pipework will be included to link Basins 1 and 2 together due to the presence of an open area / play space in the central area of the Site. A swale will convey attenuated runoff water from Basin 1 to Basin 4 (infiltration basin). Water in Basin 3 will be piped to the main drainage network along the estate road eventually discharging into Basin 4.

The infiltration basin will be constructed with due consideration to the guidance contained within CIRIA Report C574 'Engineering in Chalk'. It is important that a suitable stand-off distance (typically 20m) is maintained between the constructed infiltration feature and any adjacent structures with below-ground foundations.

7.6 Exceedance routes

The available freeboard within each basin will ensure that their respective capacity will in reality be somewhat greater than the 1 in 100-year (plus 40% for climate change) event. Due consideration, however, also needs to be given to the exceedance routes that could occur during events above

the design standard of the various components of the proposed SuDS Strategy (i.e. surface water pipework and the stormwater basins).

Figure 7.3 shows exceedance routes for two scenarios:

- 1) Surcharging water from the proposed surface water drainage pipework under storm conditions ranging from the 1 in 30-year event to the 1 in 100-year event plus climate change.

Under this scenario, water would surcharge from manholes and be safely conveyed along the road surfaces to the respective basins. These exceedance flows would be shallow and contained within road kerbing. These exceedance routes have been defined using the outline stormwater drainage routes (Figure 7.2) and the existing LiDAR DTM data. In some instances, some reprofiling (raising and lowering) of ground levels at the site will be required to ensure these drainage routes are viable as discussed previously.

- 2) Over-topping of the basins under events in excess of the 1 in 100 year plus 40% return period which has been used for the feature design in this instance.

Under these extreme events, exceedance flows from the basins will be designed to mimic the surface water flow pathway described in Section 4.3. The basins will be served with a spillway at its lowest bank that will ensure that exceedance flows will be diverted away from the residential properties. These measures will also ensure that the proposed residential units will remain flood-free under exceedance events. In the instance of Basin 3 the exceedance route for Scenario 2 events will need to cross roadways to reach the principal exceedance route (to Basin 4) and the north-eastern corner of the Site.

7.7 Water quality

SuDS techniques can be used to effectively manage the quality of surface water flowing across a site. Different methods can be used to intercept pollutants and allow them to degrade or be stored in situ without impacting the quality of water further downstream. Frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10 mm of rainfall (i.e. the 'first flush') should be adequately treated using SuDS.

The proposed development will include residential dwellings, low traffic roads and driveways. The CIRIA SuDS manual categorises runoff from residential dwellings as presenting a very low water quality hazard and runoff from low usage roads and residential driveways as presenting a low hazard rating (see Table 7).

Table 7 Water quality hazard ratings (CIRIA, 2015)

Land use	Hazard level
Residential Roof drainage	Very Low
Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.	Low
Commercial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).	Medium
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemical and fuels other than domestic fuel oil are delivered, handled, stored used or manufactured, industrial sites.	High
Trunk roads and motorways	High

The CIRIA SuDS manual (CIRIA, 2015) advocates a qualitative approach to designing a SuDS scheme for a site with a low hazard rating. This should provide adequate controls on pollutants contained in runoff water. As the proposed development is residential in nature with a low hazard rating, hazard indices of 0.5 for Total Suspended Solids (TSS), 0.4 for Metals and 0.4 for Hydrocarbons are considered applicable.

The following measures are examples which are suitable for inclusion in a drainage strategy for a residential development to mitigate a potential increase in sediment loads within on-site and off-site runoff. Removal indices are included for each feature type relative to the specific pollutant.

Table 8 Mitigation indices for proposed SuDS components

Component Type	TSS	Metals	Hydrocarbons
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Permeable paving	0.7	0.6	0.7
Attenuation basin (infiltration basin)	0.5	0.5	0.6
Pond	0.7	0.7	0.5

The attenuation and infiltration basins included within the SuDS Strategy for the proposed development will provide adequate treatment to mitigate the low hazard associated with runoff from the development.

Sediment traps (i.e. sumps within the inspection chambers of the final manhole upstream of each basin) will be used to facilitate the maintenance of these basins and reduce the build-up of potentially polluted material stored within.

The Site is with Zone III (Total Catchment) of a Source Protection Zone. The water quality mitigation measures outlined above are considered appropriate for treating runoff before infiltration occurs.

7.8 SuDS maintenance

Inspection and long-term maintenance of SuDS components ensures efficient operation and prevents failure. Surface SuDS components can be managed using landscape maintenance techniques. Table 11 describes the management and maintenance requirements for the proposed SuDS features. These requirements will be implemented following the completion of the proposed development, and will be undertaken either by the Lead Local Flood Authority, a private management company or by Thames Water, subject to ongoing discussions regarding this responsibility.

Table 9 Management and maintenance requirements for proposed SuDS

SuDS Device	Maintenance requirements	Maintenance frequency
Permeable paving	• Inspection for litter, clogging, weeds and puddles. • Sweeping of dead leaves, litter vacuuming and weed removal. • Relaying.	• Immediately before handover to owner, then monthly and 48 hrs post rainfall. • Vacuum twice and three surface sweeps (mid-summer, post winter and autumn leaf fall) annually. • As required and about 15 - 25 yrs depending on use and also consider material reuse.
Swales	• Inspection of inoperable areas e.g. eroded areas, compacted silt-laden infiltration surfaces. (soil and grass). Litter removal. • Record areas of ponding for more than 48 hrs. • Maintain grass height (+50 mm above design water level); no cutting during drought or wet periods. • Remove plant cuttings to dispose of pollutants. • Thatch removal. Prevent compaction by breaking up silt. • Repair and reinstate design levels by turfing or reseeding. • Removal of silt and dead/damaged vegetation.	• Monthly. • As above. • As required and about twice a year. • As above. • As required. • As above. • As above.
Attenuation/infiltration basin	• Litter/trash removal • Inlet/outlet cleaning • Vegetation management • Sediment monitoring and silt removal.	• Monthly • As above • As above • Annually or every 3 yrs

7.9 Additional potential recommendations

Rainwater harvesting and re-use techniques (e.g. for flushing of private WCs) should also be considered for use within each of the residential properties.

7.10 Biodiversity and amenity

SuDS schemes present opportunities to enhance habitat for wildlife onsite and this often improves the biodiversity of the vicinity. Ponds, constructed wetlands and other surface water features are landscape assets that have amenity value and improve the aesthetics of a site more than conventional drainage systems.

The use of vegetated basins will enhance the biodiversity and amenity value of the Site when compared with its current use as a golf course. Ecological diversity should be enhanced by the use of native planting within each basin.

8.0 Conclusions and recommendations

This report presents the findings of a Flood Risk Assessment and Outline SuDS Strategy for the proposed residential development at Reading Golf Course. The Site is located in Flood Zone 1 and therefore has a Low Probability of flooding from rivers and the sea – this will also be true post-development after allowing for the expected effects of climate change. The EA's Flood Map for Surface Water indicates that a surface water flow pathway runs along the northern part of the Site and appears to flow south west to north east, although this is only present under the extreme, 1 in 1000 year storm scenario. The Site is currently 'greenfield' and as such the surface water runoff from the proposed development will need to be sustainably managed.

This report provides an Outline SuDS Strategy for the Site. The principal components of the scheme are three attenuation basins and a single infiltration basin located in the lowest parts of the Site, in combination with the use of swales and permeable paving. The Seaford Chalk underlying the northern part of the Site (location of the infiltration basin) is considered an appropriate medium to receive stormwater, as are the gravelly superficial deposits where the clay content is low. This was confirmed during permeability testing in the chalk by others at the Site. There is potential to incorporate deep bore soakaways to discharge attenuated runoff water from the attenuation basins to the Seaford Chalk in full or in part; however, this method is not being considered further at present.

A preliminary assessment of the stormwater requirements for 1 in 100 year + 40% climate change storm was undertaken which shows that the proposed basins are capable of accommodating the required stormwater runoff volumes.

The proposed SuDS Strategy will also intercept, attenuate and divert the potential surface water flow to remove flood risk to the Site and reduce flood risk downgradient.

It is also noted (from a review of the local drainage asset plans) that a Thames Water foul sewer currently runs through the Site (as shown in Appendix A). This sewer will need to be realigned as part of the proposed development.

Appropriate management and maintenance arrangements for the proposed SuDS scheme will be in place throughout the lifetime of the proposed development.

9.0 References

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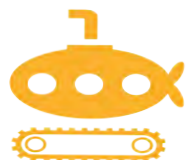
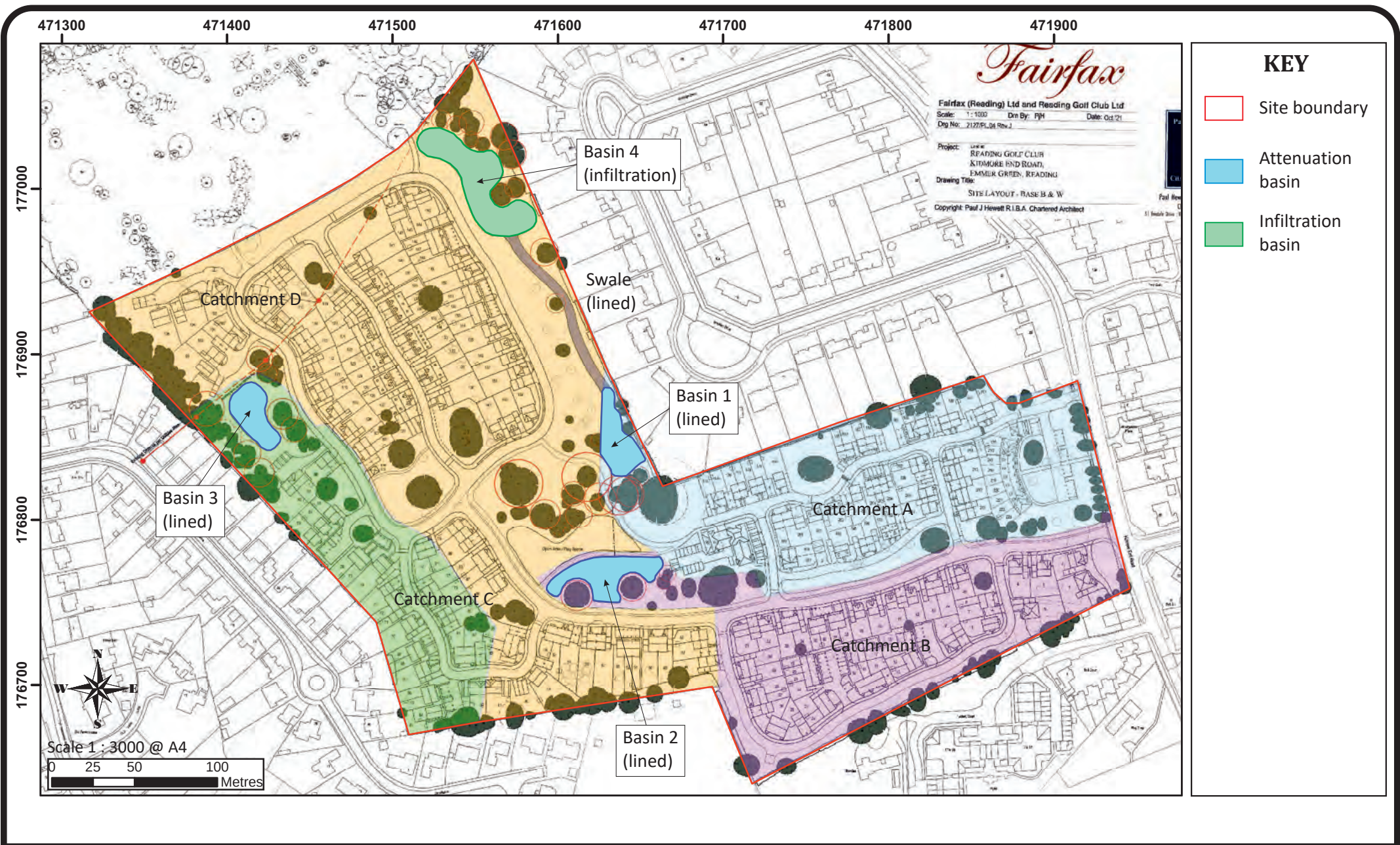
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Figures

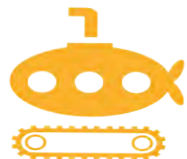
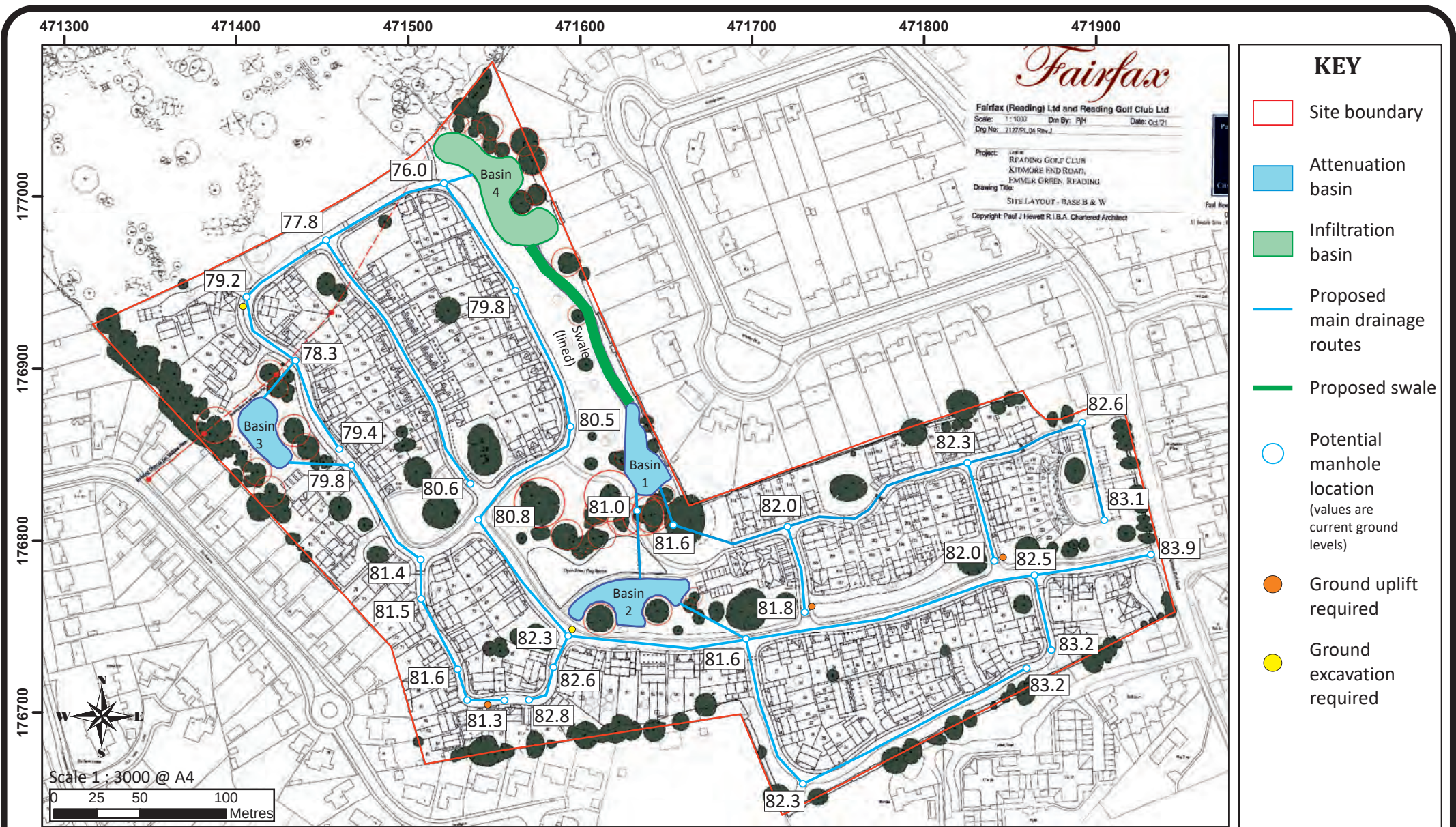


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Reading Golf Course

Figure 7.1

Drainage Catchments

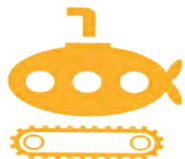
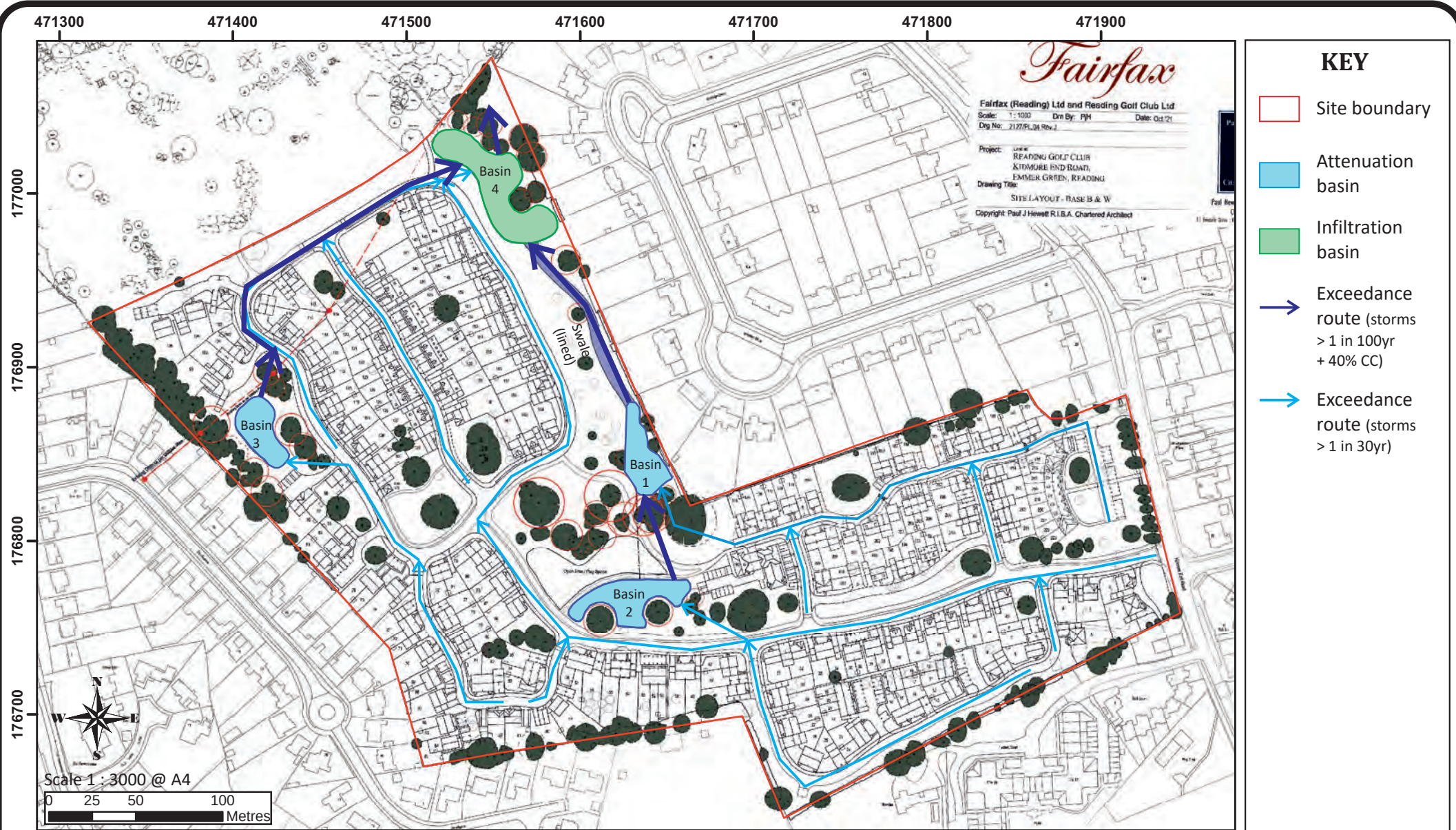


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Figure 7.2

Reading Golf Course

Preliminary Outline Drainage Routes

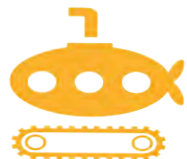


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Figure 7.3

Reading Golf Course

Exceedence Flow Routes



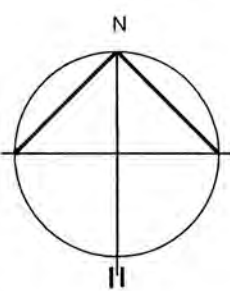
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Figure 7.4

Reading Golf Course

Site Investigation Locations

Appendix A - Proposed Development Layout



Fairfax

Fairfax (Reading) Ltd and Reading Golf Club Ltd

Scale: 1 : 1000 Drn By: PJH Date: Oct '21
Org No: 2127/PL04 Rev.J

Project: Land at:
READING GOLF CLUB
KIDMORE END ROAD,
EMMER GREEN, READING
Drawing Title:

SITE LAYOUT - BASE B & W

Copyright: Paul J Hewett R.I.B.A. Chartered Architect

Paul Hewett R.I.B.A.

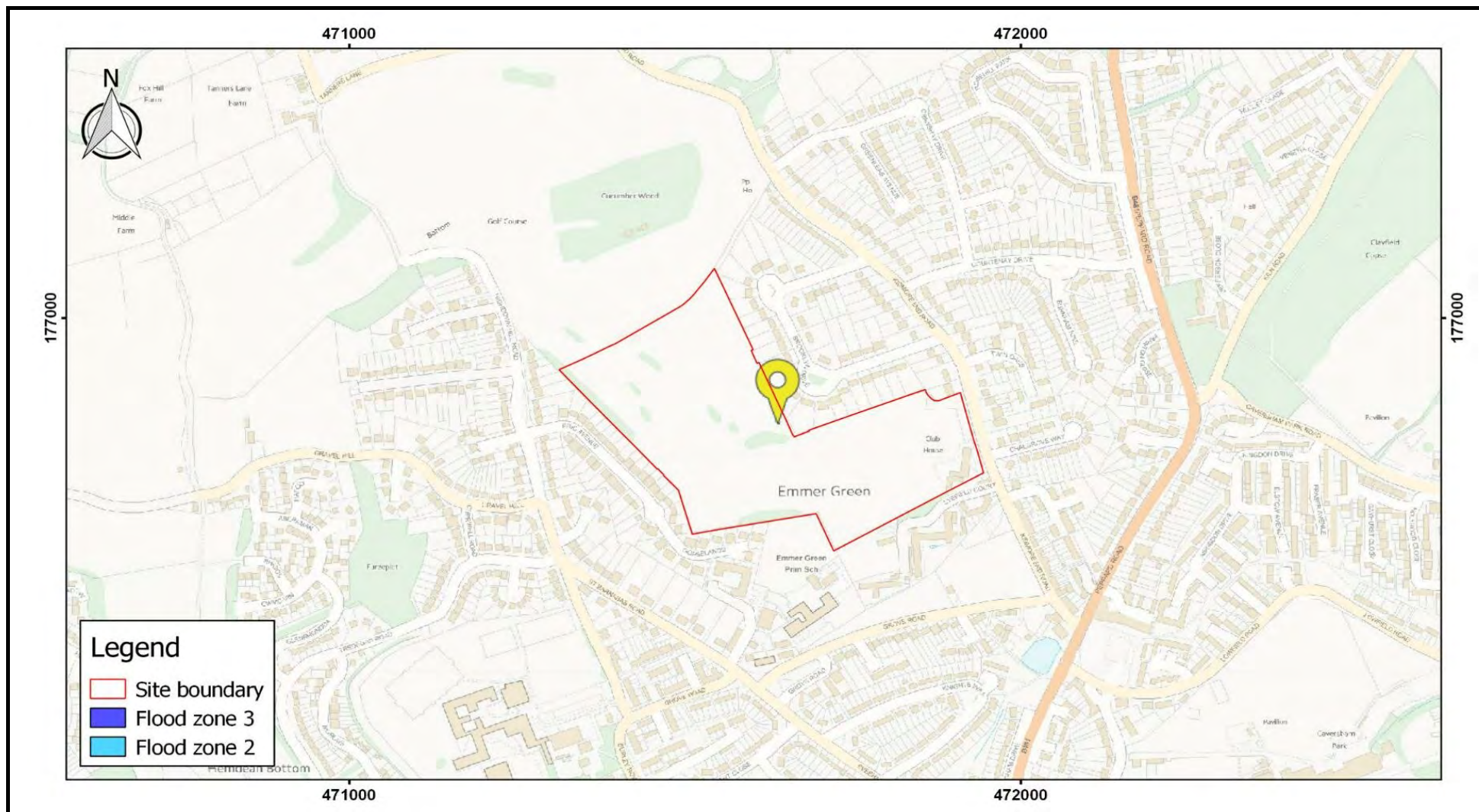
CHARTERED ARCHITECT

Paul Hewett BA(Hons)DipArch(Hons)R.I.B.A.

CHARTERED ARCHITECT

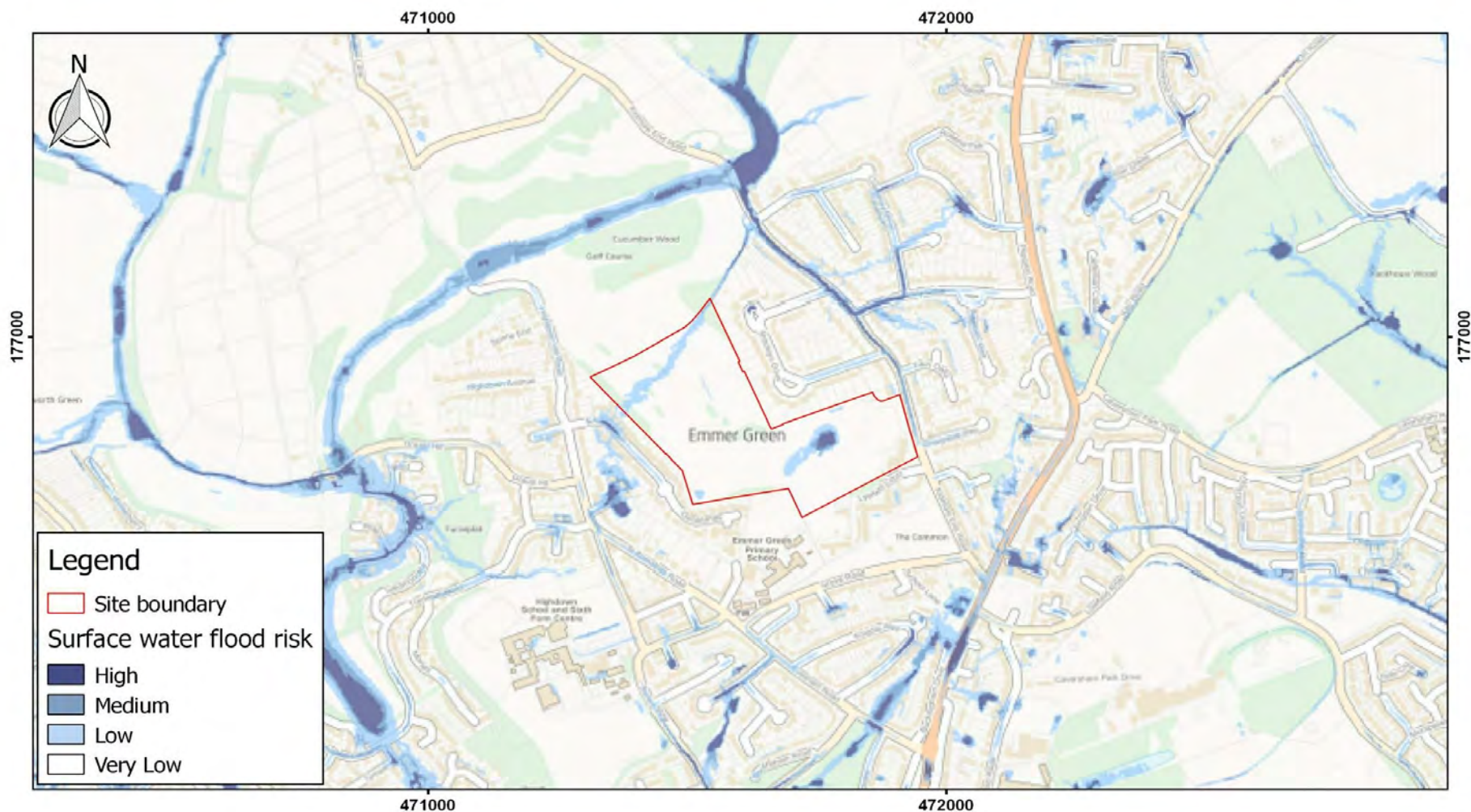
51 Foxdale Drive : The Dell : Angmering : West Sussex : BN16 4HH

Appendix B - Environment Agency Flood Map for Planning



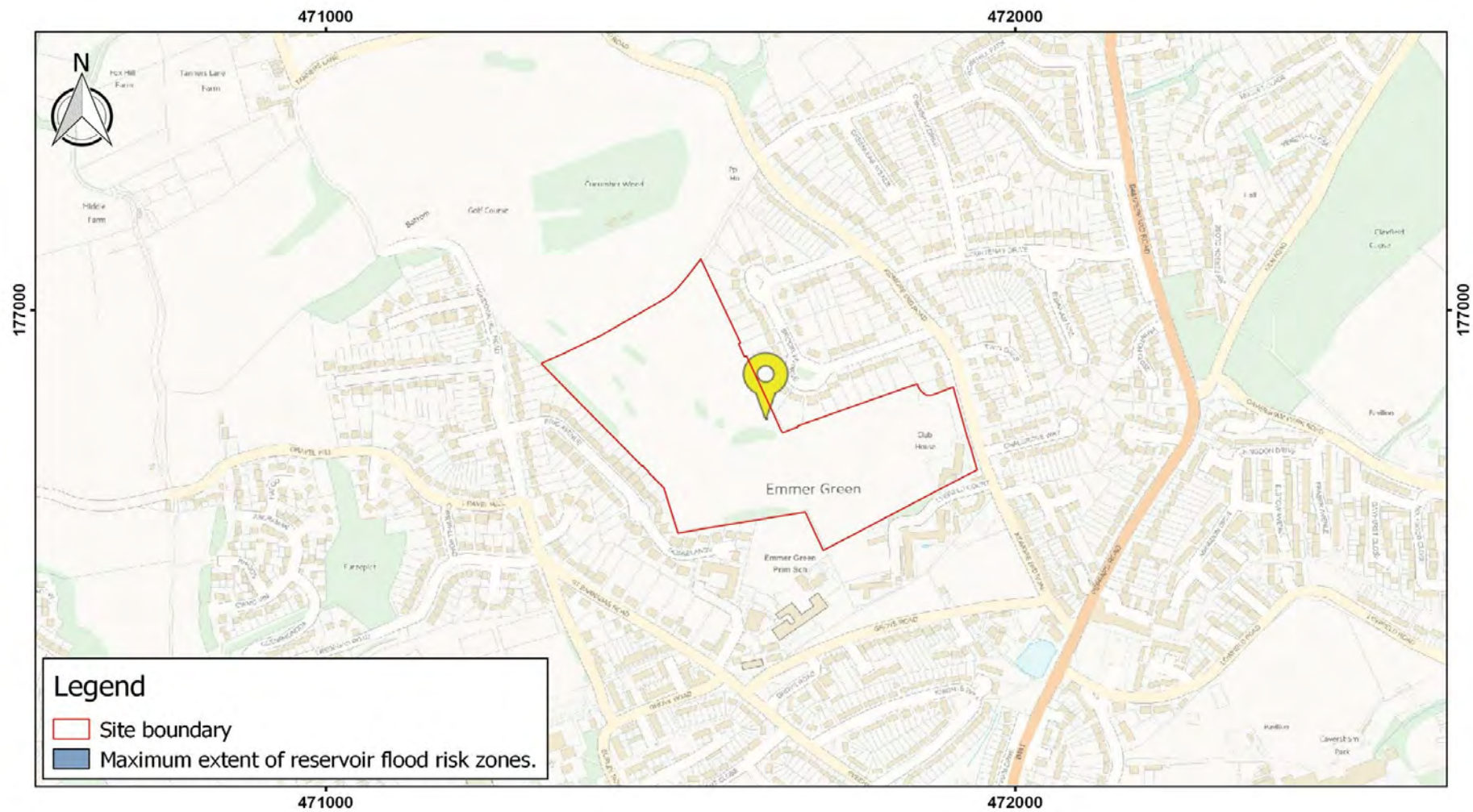
 7 Neptune Court, Vanguard Way, Cardiff, CF24 5PJ helpme@yellowsubgeo.com	Drawing Title	EA Fluvial flood risk map	Scale	NTS	
	Drawing Number	App B	Revision	0	
	Project Name	Reading Golf Club	Drawn by	JEM	
	Project Number	P21279	Checked by	GRO	
	Client	Fairfax Acquisitions Ltd	Notes	© Crown copyright 2021 OS 100062269	

Appendix C - Environment Agency Flood Map for Surface Water



Drawing Title	EA Surface water flood risk map	Scale	NTS
Drawing Number	App C	Revision	0
Project Name	Reading Golf Club	Drawn by	JEM
Project Number	P21279	Checked by	GRO
Client	Fairfax Acquisitions Ltd	Notes	© Crown copyright 2021 OS 100062269

Appendix D - Environment Agency Flood Map for Reservoirs



Drawing Title	EA Reservoir failure flood risk map	Scale	NTS
Drawing Number	App D	Revision	0
Project Name	Reading Golf Club	Drawn by	JEM
Project Number	P21279	Checked by	GRO
Client	Fairfax Acquisitions Ltd	Notes	© Crown copyright 2021 OS 100062269

Appendix E – Greenfield Runoff Rates and Stormwater Storage Requirements

Stantec UK		Page 1
Dominion House Warrington		
Date 27/03/2020 15:57 File	Designed by hekelly Checked by	
Innovyze		Source Control 2018.1.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 1.00 Soil 0.150 Area (ha) 12.093 Urban 0.000 SAAR (mm) 664 Region Number Region 6 Results 1/s QBAR Rural 4.6 QBAR Urban 4.6 Q100 years 14.7 Q1 year 3.9 Q30 years 10.4 Q100 years 14.7		
©1982-2018 Innovyze		

Catchment A (Basin 1)

Storage Estimate

Return Period (years)	100	
Climate Change (%)	40	
Impermeable Area (ha)	0.730	Update
Peak Discharge (l/s)	5.000	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	0.05760	Calc
Required Storage (m³)	Calc	
from	624	
to	1047	
With infiltration (m³)		
from	234	
to	667	

Catchment B (Basin 2)

Storage Estimate

Return Period (years)	100	
Climate Change (%)	40	
Impermeable Area (ha)	0.870	Update
Peak Discharge (l/s)	5.000	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	0.05760	Calc
Required Storage (m³)	Calc	
from	794	
to	1338	
With infiltration (m³)		
from	280	
to	810	

Catchment C (Basin 3)

Storage Estimate

Return Period (years)	100	
Climate Change (%)	40	
Impermeable Area (ha)	0.390	Update
Peak Discharge (l/s)	5.000	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	0.05760	Calc
Required Storage (m³)	Calc	
from	271	
to	423	
With infiltration (m³)		
from	123	
to	328	

Catchment D (Basin 4)

Storage Estimate

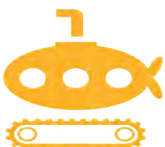
Return Period (years)	100	
Climate Change (%)	40	
Impermeable Area (ha)	1.530	Update
Peak Discharge (l/s)	0.000	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	0.05760	Calc
Required Storage (m³)	Calc	
from	3752	
to	3752	
With infiltration (m³)		
from	503	
to	1598	

Total (Basin 4)

Storage Estimate

Return Period (years)	100	
Climate Change (%)	40	
Impermeable Area (ha)	3.520	Update
Peak Discharge (l/s)	0.000	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	0.05760	Calc
Required Storage (m³)	Calc	
from	8631	
to	8631	
With infiltration (m³)		
from	1158	
to	3676	

Calculations using the 'Storage Estimate' tool within Causeway Flow+ (version 10.2) drainage design software



Ref: P21-223 YSG Reading Golf Club
Date: 04/11/2021

Reading Golf Club

Appendix E

Causeway Storage Estimate Tool Outputs

Appendix F – Geo-Environmental Report – Reading Golf Club

**GEOENVIRONMENTAL ASSESSMENT
READING GOLF CLUB
KIDMORE END ROAD, RG4 8SQ
REDROW HOMES THAMES VALLEY
GEA-21962B-19-476
NOVEMBER 2019**

IDOM



GEOENVIRONMENTAL ASSESSMENT
READING GOLF CLUB
KIDMORE END ROAD, RG4 8SQ
REDROW HOMES THAMES VALLEY
GEA-21962B-19-476
NOVEMBER 2019

Current Document Details

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Document Revisions

Rev	Date	Author	Approved	Issued	Remarks
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EXECUTIVE SUMMARY

A Geo-Environmental Assessment was requested by Redrow Homes Thames Valley. The purpose of the assessment was to identify any contaminative or geotechnical issues associated with former land use at *Reading Golf Club, Kidmore End Road, RG4 8SQ* which might impact on the site's purchase and redevelopment.

SITE DETAILS

Approximate site area	12.3 ha
Current use / historic use	Golf Course
Proposed use	Residential development with gardens.

PHASE 1 NON-INTRUSIVE INVESTIGATION

Expected geology	Superficial: terrace gravels over western two-thirds of site. Bedrock: Lambeth Groups (clays and sands) in the south and Chalk in the north.
Groundwater	Terrace gravels and Lambeth Group classed as Secondary A aquifers. Chalk classed as a Principal Aquifer. Site rests within Total catchment of a groundwater protection zone.
Surface water	No surface water receptors in vicinity. Site is within a Flood Zone 1.

PHASE 2 EXPLORATORY INVESTIGATION

Ground Conditions	Topsoil over mainly medium dense, locally dense very clayey sand and gravel or firm and stiff very gravelly clay. Shallow chalk identified in north-east.
Contamination	No significant contamination identified.
Geotechnical issues	Locally loose/soft conditions persist to > 2m depth in east of site. Potentially shrinkable soils in zone of influence of trees. There are records of chalk cavities (solution features) off site but within the vicinity. Therefore potential for weak solution feature infill or voids possible in north of site. Low permeability soils in south. Infiltration drainage may be limited to northern areas.

RECOMMENDATIONS

Geotechnical	Mostly shallow strip footings. Deeper foundations or possible ground improvement where loose/soft strata found to depth and in zone of influence of trees (subject to tree survey). Trial pit investigation recommended for soakage testing, to target soft zones, investigate desiccation around trees, inspect chalk composition and generally, investigate shallow strata for foundation assessment.
--------------	---

Remediation	No requirements identified to date.
Waste classification	Soil arisings likely to be non-hazardous and natural soils anticipated to be accepted as inert waste.
Re-use of site-won materials	Site won materials are currently indicated to be suitable for use. It is recommended that a Materials Management Plan is in place where soil arisings are intended for re-use as fill.

SECTION 1 INTRODUCTION

- 1.1 Redrow Homes Thames Valley (Redrow) proposes to purchase an area of land comprising the southern part of the Reading Golf Club, located at 17 Kidmore End Road, Emmer Green, Reading for residential development purposes. An appraisal layout provided shows the proposed development comprises 228 dwellings with private gardens, estate roads and retained open space with surface water storage/attenuation. IDOM Merebrook Limited (IDOM) has been commissioned by Redrow to undertake preliminary site investigation works and to advise on the geo-environmental implications of the purchase and redevelopment of the site for the proposed end use.
- 1.2 The objectives of the investigation are to:
- i.* Assess surface and sub-surface ground conditions present at the site;
 - ii.* Identify hazards associated with ground contamination which may place constraints on the site and the proposed development;
 - iii.* Evaluate the risks associated with any identified hazards;
 - iv.* Provide preliminary recommendations for the mitigation of any significant risks identified; and
 - v.* Provide preliminary geotechnical recommendations.
- 1.3 A Phase 1 (Non-intrusive Investigation) and a Phase 2a (Preliminary Exploratory Investigation) have been undertaken for the subject site.
- 1.4 This report presents the findings of the geo-environmental investigation and provides an interpretation of the geo-environmental conditions that exist at the site. The contaminative status of the site and the implications with respect to development have been interpreted in accordance with the current government guidance on source-pathway-receptor risk assessment. This report uses a Tier 1 risk assessment to ascribe a conservative qualitative appraisal of the hazards associated with the site.
- 1.5 This report has been prepared for Redrow Homes Thames Valley for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties making reference to the report should consult Redrow Homes Thames Valley and IDOM as to the extent to which the findings may be appropriate for their use.

SECTION 2 PHASE 1 (NON-INTRUSIVE INVESTIGATION)

2.1 INTRODUCTION

- 2.1.1 The non-intrusive investigation has been conducted with reference to the documents and sources detailed in Table 1 below:

Table 1: Published Data and Information Sources

SOURCE DATA	GROUNDSURE DATA
BGS 1:50,000 Series Geological Sheet 268 Reading	Ordnance Survey (OS) historical maps scaled at 1:10,560, 1:10,000, 1:2,500 and 1:1,250 dated 1878-2019.
BGS Geology of Britain 1:50,000 online maps	Water abstraction, discharge and pollution data
Radon: guidance on protection measures for new dwellings	Registered waste management sites
Environment Agency (EA) online data maps	Mining records and natural ground stability data
UK National Air Quality Archive, online	Protected areas of environmentally sensitive land use or conservation
	Other relevant designations and/or authorisations and Trade Directory entries

- 2.1.2 The above sources are all authoritative and it is believed that they are reasonably reliable. However, independent verification of the information supplied has not necessarily been carried out and IDOM cannot be held liable for inaccuracies or deficiencies in the information.

2.2 SITE LOCATION AND SETTING

- 2.2.1 The site is located to the west of Kidmore End Road, Emmer Green, Reading.
- 2.2.2 The site occupies an area of approximately 12.13 hectares located at National Grid Reference 471939, 176777 and indicated in Figure 1 below.



Figure 1. Site location.

- 2.2.3 The site is bounded to the south by residential development off Lyefield Court and the sports field of Emmer Green Primary School. To the west is established residential development off Eric Avenue. To the northern boundary (which also marks the local authority boundary) is the northern part of the golf course and to the east is established residential development off Brooklyn Drive and the highway of Kidmore End Road. The general setting is predominantly residential to the south, east and west and rural/semi-rural to the north.
- 2.2.4 The site is currently in use as a golf course with mown grass, scattered trees and groups of trees, sand bunkers and low mounds, with the clubhouse and car park occupying the south-eastern portion adjacent to Kidmore End Road.
- 2.2.5 The site topography generally falls from the south to north. At its highest the site elevation sits at around 84 m AOD at the site entrance in the south-east, falling to around 75.20 m AOD in the north-east corner of the development area. Further off site to the north, the land slopes away more markedly.
- 2.2.6 No obvious contaminative uses were noted on the adjacent land.

2.3 SITE HISTORY

- 2.3.1 The site history, based on a review of the historic and current maps, dating from 1878 to 2019 is summarised below. Potentially contaminative land uses are shown in **bold**. Copies of key maps used in this review are provided in Appendix 2.

Table 2: Summary of the key features shown on historic maps

DATA SOURCE	SITE / SURROUNDINGS
1878 – 1882 (1:10 000 and 1:2500 scales).	Site - no significant features shown on site. Surroundings - mostly fields with scattered farms and dwellings. Small gravel pit 350 m to the west. Brick and Tile Works covering land 350-750 m to the east. Small pit (later labelled a Chalk Pit 300 m to the north.
1900-1915 (1:10 000 and 1:2500 scales).	Site – no significant features or changes noted. By 1910, the site is labelled as a Golf Course in the north with a small square structure in the south-east corner. Surroundings – number of small old chalk pits shown off site to the north. St Benet's Home built adjacent to the southern boundary.
1932-1956 (1:10 000 and 1:2500 scales).	Site – little change on site. The small square structure in south-east of site has been enlarged and is labelled as a Club House Surroundings – residential development along Brooklyn Drive and generally increasing density of development.
1961-1973(1:10 000 scale).	Site – little change on site. Surroundings – generally increasing density of development. Allotments shown adjacent to the southern boundary. Emmer Green Primary School shown to the south by this period. Progressive redevelopment of the former Brick and Tile Works to the east.
1990-present (1:10 000 scale).	Site – little change on site. Enlargement/replacement of the Club House and car park. Surroundings – St Benet's Home replaced by residential development along Lyefield Court and continued residential development.

- 2.3.2 In summary, historic plans show that the site has only been developed as a Golf Course prior to which it was presumably farmland. Anecdotal evidence indicates fire damage and replacement of the club house structures in the south. Off-site, development includes sporadic extraction of gravel and chalk and more extensive brick works to the east which ceased several decades previously. Otherwise, the surrounding land has undergone development for residential, allotment and school uses.
- 2.3.3 Given the nature of the historical mapping process (scale, representation of conditions at discrete time intervals frequency etc.), any such maps and plans may not provide a comprehensive account of a site's history. Identification of pertinent

land uses and associated potentially contaminative activities, may therefore be absent from mapping records.

2.4 GEOLOGY

2.4.1 The published geological map indicates the presence of superficial drift deposits of Terrace Gravels of the River Thames (Black Park Gravels) covering the western parts of the site. Online descriptions of this unit from the BGS indicates it attains thicknesses of between 1 and 6 m and an average of 3 m thickness. These are shown to be absent in a zone adjacent to Brooklyn Drive and the south-east corner of the site.

2.4.2 The underlying bedrock geology comprises two formations: the Seaford and Newhaven Chalk Formations which are indicated to underlie the northern third (approximately) of the site. These comprise off-white and white Chalk with flints. The majority of the site (southern two-thirds) is indicated to be underlain by the Lambeth Group. This is a laterally variable sequence mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and lignites and occasional sandstone and conglomerate which directly overlies the Chalk Group. In the Reading area this typically comprises mottled clays and sands.

2.4.3 A borehole record located in the golf course 106 m to the north (drilled in 1990 presumably for irrigation purposes), records 0.30 m of 'soil and pebbles' overlying Chalk with flints proved to at least 70 m depth. The record of this borehole (reference SU77NW68) is included in Appendix 3.

2.4.4 From mapping evidence, no artificial ground deposits are shown on the site, however it is likely that modelling/landscaping of the golf course and installation of drainage and irrigation will have resulted in placement of mounds and trench fill. This is likely to comprise re-worked natural materials. Anecdotally, it was indicated on site that localised filling is present in the form of soakaways. Off-site the nearest artificial ground feature is a small area of worked ground 215 m to the north-west. This likely represents a small chalk pit shown on 19th and early 20th century mapping.

2.5 CHALK CAVITIES

2.5.1 Chalk extraction is indicated in the area to the north which can result in filled ground. Also, as a soluble rock, dissolution features can exist as both voids and weakly infilled structures. A search of databases held by PBA records no features from mining, extraction or natural chalk cavities on the site itself. However, there are three locations within 250 m of the northern half of the site where natural cavities features have been recorded. These include solution pipes located along Brooklyn Drive 60 m to the north of the site. Two locations between 139 and 230 m west are listed where sink holes have been recorded, one of which also is listed as having a swallow hole and the other co-occurring with a solution pipe. The recorded incidences to the west should, based on the mapped geology, be located where terrace gravels overlie the chalk.

2.6 HYDROGEOLOGY

- 2.6.1 The Black Park Gravels are classed as a Secondary A aquifer. Secondary A aquifers may be important in providing local water supplies and base flow to streams.
- 2.6.2 Of the bedrock formations, the Lambeth Group is also classed as a Secondary A aquifer. The Chalk is classed as a Principal aquifer. These are formations which are capable of supporting large scale abstractions for public supply.
- 2.6.3 The site is shown to be located within a Zone 3 groundwater source protection zone (total catchment). There are however no licensed potable water abstractions within 2000 m of the site. The nearest licensed abstraction is located to the Golf Club – 106 m to the north of the site. The BGS borehole record gives a depth to groundwater of 37 m in 1990. There are no other abstraction licences listed to within 1 km of the site.

2.7 HYDROLOGY

- 2.7.1 There are no surface water features within 250 m of the site. The nearest listed inland river is located 338 m from the site.
- 2.7.2 There are no surface water abstraction licences listed within 1 km of the site.
- 2.7.3 From EA mapping the site is shown to be within a Flood Zone 1 (<0.1 annual risk of flooding from rivers and the sea).
- 2.7.4 The geological conditions indicate a hazard from groundwater flooding – where groundwater levels may rise into basements and belowground infra structure. This can occur where granular strata overlie low permeability soils. The highest susceptibility rating for groundwater flooding within a 50 m radius search area is listed as *Potential at Surface*. The confidence rating for this is high. This indicates that unless there is evidence of groundwater flood events having occurred no further action is required.

2.8 CURRENT SITE ISSUES

- 2.8.1 Potentially significant environmental issues have been investigated within relevant distances of the site, based on the database of records supplied by Groundsure. These relate to the following searches:
- i.* Water discharge or pollution incidents within 250 m of the site;
 - ii.* Waste management sites within 250 m of the site;
 - iii.* Statutory authorisations within 50 m of the site;
 - iv.* Trade directory entries of possible contaminative use within 50 m of the site;
 - v.* Special protection or conservation areas within 50 m of the site; and

vi. Any other relevant issues.

2.8.2 Potentially significant environmental issues identified by the above searches are summarised in Table 3 below.

Table 3: Potentially significant environmental issues

ENVIRONMENTAL CATEGORY	DESCRIPTION
Water discharge or pollution incidents within 250 m	None listed
Waste management sites within 250 m	There are no currently licensed or historic licensed landfill sites within 250 m. From BGS/DoE databases, there is one historical feature (infilled pit) located 79 m north-west. This is unlikely to impact the subject site. There are no other waste sites listed within the search area.
Statutory authorisations within 50 m	None listed
Current and historical industrial possible contaminative uses within 50 m	There is an electrical feature (substation) located 29 m to the east. This is unlikely to affect the subject site.
Special protection or conservation areas within 50 m	None listed.
Other relevant issues	None identified at this time.

2.9 INDICATIVE GROUND STABILITY HAZARDS

2.9.1 The following ground stability hazards and their hazard ratings have been supplied by Groundsure based on published mapping data:

- i. Shrink-swell soils – moderate.
- ii. Landslides – very low.
- iii. Soluble rocks – high (this would apply mainly in the north of the site directly underlain by Chalk or Terrace deposits over Chalk).
- iv. Compressible ground – negligible.
- v. Collapsible rocks – very low.
- vi. Running sand – very low.

2.10 RADON GAS

- 2.10.1 The site does not lie within a Radon Affected Area as defined by the former Health Protection Agency, now Public Health England (less than 1% of houses are above the action level). Guidance issued by the Buildings Research Establishment (BRE-211) indicates that radon protection measures are not required for new dwellings.

2.11 AIR QUALITY

- 2.11.1 The site does not lie within a designated Air Quality Management Area (AQMA) for Local Authority. Proposals for a development of this scale may require an air quality assessment if a sufficient number of vehicle journeys are generated.

2.12 ECOLOGY

- 2.12.1 There are no designated environmentally sensitive sites on the property. An area of deciduous woodland is shown in the north-east of the site which is listed on the MAGIC database priority habitat inventory. It is possible that an ecological assessment of the site and mitigation measures may be required.

2.13 PREVIOUS INVESTIGATIONS

- 2.13.1 No known previous ground investigation data exists for the site. The site has been the subject of a Pre-application Report by Temple Group for Fairfax Properties for a 350 unit development and proposed medical centre which included land to the north. This report included the topics of flooding, drainage, utilities, noise and vibration and socio-economic aspects of the development.

2.14 PRELIMINARY CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

- 2.14.1 From the Phase 1 assessment a preliminary site conceptual model and risk assessment have been produced using the framework established in Part IIA of the *Environmental Protection Act 1990* and detailed in Contaminated Land Report *CLR11 - Model Procedures for the Management of Land Contamination*.
- 2.14.2 Risk from contamination has been assessed using the source-pathway-receptor and pollutant linkage methodology, whereby a risk can only exist if all elements of: source, pathway and receptor, are present.
- 2.14.3 Potential Sources. Very limited potential. Fuels and oils are likely to be stored for grounds maintenance equipment but this would be localised and likely kept and used within or next to buildings. Background soil geochemistry for a range of heavy metals are not indicated to exceed screening levels appropriate for the development. Artificial and filled ground with the potential act as sources of gas have not been identified on or in proximity to the site. Dissolution of chalk soils can generate elevated carbon dioxide concentrations.
- 2.14.4 Potential Pathways. Contact with soil by existing users is limited by the high degree of grass cover. Future development would increase the potential for exposure to soil

via oral, dermal and inhalation pathways and introduce gas ingress pathways in new dwellings.

- 2.14.5 Potential Receptors. Currently of low sensitivity, mainly adult users being present on site for short duration periods. Future development would introduce a sensitive child receptor, building materials (such as water pipes and concrete).
- 2.14.6 From the Phase 1 assessment a preliminary site conceptual model has been produced as Table 4 which identifies the potential pollutant linkages. These have been used to inform the Phase 2 intrusive investigation presented in the subsequent sections.

Table 4: Preliminary Conceptual Model

POSSIBLE POLLUTANT LINKAGE			RISK CHARACTERISATION
POTENTIAL SOURCES	PATHWAYS	RECEPTORS	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (current users)	No risk identified Ground conditions anticipated to be substantially natural.
	Ingestion and inhalation of contaminated soil and dust	Human health (current users)	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (future residents and construction workers)	No risk identified Ground conditions anticipated to be substantially natural. Use of fuels and oils likely to be highly localised.
	Ingestion and inhalation of contaminated soil and dust	Human health (future residents and construction workers)	
Asbestos (made ground)	Ingestion and inhalation of contaminated soil and dust	Human health (future residents and construction workers)	Low risk identified Potential for made ground to contain asbestos from demolition/refurbishment of club buildings
Contamination (all forms)	Vertical migration to aquifer	Controlled waters	Low risk identified Presence of shallow gravel and chalk aquifer receptors but very low potential for contamination to be present.
Contamination (all forms)	Horizontal migration to surface water	Controlled waters	No risk identified No surface waters in the vicinity
Hydrocarbons	Direct contact	Plastic water pipes	Low risk identified No risk anticipated over majority of the site but cannot rule out presence of localised shallow hydrocarbon contamination at this stage.
Hazardous Gas/Vapours In soil	Ingress into buildings and voids	Human health (future residents and construction workers)	Low risk identified Significant sources of gas generation have not been identified. Unlikely that carbon dioxide from chalk would be present at levels likely to ingress into dwellings.

POSSIBLE POLLUTANT LINKAGE			RISK CHARACTERISATION
POTENTIAL SOURCES	PATHWAYS	RECEPTORS	
Adjacent Land	Dust, groundwater migration, surface run-off and gas migration	Human health (current and future users)	No risk identified Unlikely to be significant sources.

SECTION 3 SITE INVESTIGATION RATIONALE

3.1 INTRODUCTION

- 3.1.1 A site investigation rationale has been devised in accordance with the findings of the Phase 1 investigation and the resultant preliminary conceptual site model and risk assessment. The purpose of the intrusive investigation was to identify the main stratigraphic sequence for foundation design purposes, presence of permeable soils and to confirm a natural soil sequence. Intrusive sampling locations were chosen on the basis of providing broad spatial coverage of the site, as far as the existing land use allowed (greens and fairways were avoided). There were intended primarily to assess the variation in ground conditions which may arise from the transition between areas underlain by superficial deposits, Chalk and the Lambeth Group. Due to the active use as a Golf Course, targeting around and within buildings was not undertaken.
- 3.1.2 No specific contaminants of concern were identified within the main golf course area and selected soil samples were scheduled for a broad suite of common contaminants.

3.2 SITE INVESTIGATION METHODS

- 3.2.1 An intrusive investigation was carried out by IDOM on 15 and 16 October 2019 and comprised the following scope of work:
- i. Three cable percussion boreholes (MBH1-MBH3) drilled to 8.45 metres below ground level (m bgl);
 - ii. Twelve shallow windowless sample probe holes (MWS1 to MWS12) to depths of 1.40 to 5.0 m bgl. The shallowest drilled holes were terminated upon reaching dense soils as determined from SPT results.
- 3.2.2 Exploratory hole locations are indicated on drawing 304-001 in Appendix 1. Logging of exploratory holes was undertaken by an IDOM Officer. Exploratory hole logs are contained in Appendix 3.
- 3.2.3 Light cable percussion equipment was used to advance borehole MBH1-MBH3. Standard Penetration Tests (SPTs) were performed at approximate 1 metre intervals. The tests involved driving a steel cone tipped series of rods into the ground over a distance of 450 mm using the repeated blows of a 63.5 kg weight allowed to

free fall over a distance of 760 mm. The total number of blows required for the final 300 mm penetration (the 'N' value) is recorded on the window sample logs.

- 3.2.4 As the casing was advanced, falling head permeability tests were conducted within a 0.50 m section of the underlying soil profile beneath the base of casing. Two tests were performed in each hole with test depths decided on the day, depending on the ground conditions encountered. Boreholes were then backfilled with arisings on completion.
- 3.2.5 A tracked windowless sampling rig was used to advance MWS1-MWS12. This comprised a rig-mounted drop hammer to drive a hollow steel barrel into the ground. The barrel is recovered along with a removable plastic sleeve, which lines the barrel and holds a core of soil which is retracted for logging and sampling. SPTs were performed at approximate 1 m intervals in all windowless sample holes.
- 3.2.6 Pipes for gas and groundwater monitoring were installed in five windowless sampler holes (MWS1, MWS3, MWS5, MWS9 and MWS12). These comprised an upper section of plain 50 mm diameter pipe (from the ground surface up to 1 m long) with a slotted pipe section continuing to the base of the hole in window samples. Pipes were fitted with sealed bungs and gas taps and with a steel protective cover concreted in place.
- 3.2.7 Representative soil samples were taken from various depths and strata to assess the contaminative status of the site. Soil samples were submitted to an MCERTS/UKAS accredited laboratory for chemical analysis of a broad suite of potential contaminants. The results are provided in Appendix 4.
- 3.2.8 A programme of geotechnical laboratory testing was performed on selected soil samples obtained from the boreholes, comprising classification and strength tests. Chemical testing was also undertaken to assess the aggressiveness of the ground with respect to buried concrete. The results are provided in Appendix 5.

SECTION 4 GROUND CONDITIONS

4.1 SURFACE GROUND CONDITIONS

- 4.1.1 Hardstanding present at site entrance and car parking around club house. Site is mostly grass and scattered trees and paths.

4.2 SUB-SURFACE GROUND CONDITIONS

- 4.2.1 Ground conditions were generally in accordance with the published geology. However, suspected superficial deposits comprising sandy gravelly clays were found further east than shown on the geological map. These are indicative of alluvially reworked Lambeth Group soils or terrace deposits.

- 4.2.2 A summary of the ground conditions encountered is presented in Table 5, whilst a more detailed assessment of the strata is contained in the following sections of the report.

Table 5: Summary of Sub-surface Ground Conditions

STRATA	DEPTH TO TOP RANGE (m bgl)	THICKNESS RANGE (m)
Made Ground	0.0	0.40
Topsoil	0.0	0.20-0.40
Superficial strata - Terrace Deposits	0.20-0.40	0.80-5.80
Lambeth Group	2.70-6.00	1.20->2.45
Newhaven and Seaford Chalk	1.20-6.00	>7.25

4.2.3 Made Ground

- 4.2.3.1 Made ground was present in two locations: MWS11 and MWS12 as 0.40 m of sandy clayey loam with fine to medium gravel of flint and sparse brick fragments, indicative of a re-worked/disturbed topsoil.

- 4.2.3.2 There was no visual or olfactory evidence of contamination in this stratum.

4.2.4 Topsoil

- 4.2.4.1 This was present at the surface in all exploratory holes except MWS11 and MWS12, as 0.20 to 0.40 m of brown loam with flint/chert gravel.

4.2.5 River Terrace Deposits

- 4.2.5.1 Strata consistent with superficial alluvial Terrace Deposits were encountered in all locations although they displayed variability in clay content across the site. In MBH1 and MBH2 they typically comprised a rusty brown clay matrix-supported sandy flint gravel and cohesive soil of slightly gravelly clay, typical of soils which could informally be described as 'hoggin'. Locally, such as in MWS2, a slightly clayey sand was dominant and a gravelly sand with little or no clay was described in MWS6. In some areas superficial deposits may represent reworked Lambeth Group materials, comprising mainly clay and silt but indicated by the presence of flint gravel.

- 4.2.5.2 Samples at 1 m depth from MBH1 and MBH2 were classified by wet sieve analysis which determined these as very clayey very sand GRAVEL and sandy gravelly CLAY, respectively. Three samples from MBH1-MBH2 at 2.0 m and in MBH3 at 1 m were subject to determination of Atterberg Limits which gave plasticity indices of 21-37% and liquid limits of 41-68% which indicate medium and high plasticity clay of medium volume change potential

- 4.2.5.3 Groundwater was not struck however wet gravel was observed in: MWS6 from 1.2 m, in MWS5 around 2.0 m, MWS10 at 3.95 m and MWS12 below 1.80 m.
- 4.2.5.4 In situ penetration tests gave SPT N values in the granular layers between 12->50 indicating mainly medium dense and dense ground but with an N value of 6 in MWS3 at 1 m indicating loose conditions. Looser conditions may be anticipated in saturated gravel layers. In the strata logged as predominantly cohesive, N values of 11 to 32 were recorded but with a singular low value of 4 recorded in MWS3 at 2 m. These indicate mainly firm medium strength and stiff high strength clays. It is noted that artificially high values may be returned where a high gravel content or coarse gravel is present.
- 4.2.6 Lambeth Group
 - 4.2.6.1 Strata which were considered to belong to the Lambeth Group were observed in three locations: MBH1 below 6 m depth, in MWS9 and MWS11, these all being in the eastern and southern areas and inferred from the absence of flint gravel and the mottled colouration. The stratum was described as a stiff red silty clay, grey clay and silt with grey mottled sandy layers. SPT N values were recorded in the range of 14-41 indicating firm approaching stiff and very stiff high strength conditions.
- 4.2.7 Chalk
 - 4.2.7.1 This was identified in MBH2, MBH3 and MWS3. It was recovered as an off-white silt with medium gravel-sized weak clasts and sparse flint gravel. From the disturbed samples, the composition is indicative of structure Grade Dm Chalk, however, this method of recovery may not provide a fully representative picture of the chalk grade. SPT N values of typically 11-17 in cable percussion boreholes and 21-36 in MWS3 are indicative of a more competent material.
 - 4.2.7.2 Groundwater not struck in this stratum.

SECTION 5 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

5.1 FOUNDATIONS

- 5.1.1 The proposed development is indicated to comprise low-rise detached dwellings and, in the majority of investigation locations, the identified ground conditions indicate that the use of traditional strip footings should be feasible. For areas underlain by cohesive soil of medium volume change potential, a minimum foundation depth of 0.90 m will be required and 0.75 m depth in areas underlain by granular soils. Where foundations span granular and cohesive soil, use of light mesh reinforcement is recommended.
- 5.1.2 From SPT data obtained at 1 m depth, a safe allowable bearing pressure of at least 125 kN/m² is available for medium dense gravels and firm to stiff medium/high strength clay. Higher N values at shallow depth have been recorded, however in view of the variability in the superficial deposits and that coarse gravel content may

give rise to artificially high values, it is recommended that allowable bearing pressures be limited to the value recommended above at this stage. The exceptions are MWS3 where loose conditions were found at 1 and 2 m depth and in MWS8 where soft clay was found at 1 m before firm conditions were identified at 2 m depth. Here allowable bearing pressures have been inferred as low as 35 to 60 kN/m² and deep strip or possible abnormal foundations (ground improvement or piles) may be required in this area. In view of the preliminary nature of the investigation and the lateral variation between granular and cohesive soils, further investigation of this area is recommended to allow more definitive foundation recommendations.

5.1.3 Foundation depths within the zone of influence of trees, foundation depths should be increased in accordance with NHBC standards.

5.1.4 From inspection of disturbed samples recovered in boreholes, the chalk is indicated to be unstructured and matrix dominated. However, the majority of SPT N values indicate fairly competent ground conditions more indicative of clast dominated chalk. At this stage it is recommended that allowable bearing pressures in shallow chalk be limited to 75-100 kN/m², assuming matrix dominated chalk will be present. It is recommended that trial pits are excavated to allow fuller inspection of the chalk grade at shallow depth.

5.1.5 Solution features have been recorded within the vicinity of the site, including to the west where a cover of superficial terrace deposits is mapped. This indicates potential constraints for foundation design, although it is noted that recorded solution features are located in areas of existing residential development. It is recommended that a trial pit investigation is undertaken in the area of chalk to allow more extensive inspection of the ground and provide a fuller assessment of the risks and recommended solutions (for example, use of rafts). As a minimum vigilance or a watching brief by a geotechnical specialist is recommended during foundation excavations. Where weak ground or infill is observed probing of plots may be required to assess their extent.

5.2 **EXCAVATIONS AND GROUNDWATER**

5.2.1 Excavations are indicated to remain stable in the short-term, however, where they are to remain open for extended periods or where man-entry is proposed, they should be supported or battered back to a safe angle.

5.2.2 Groundwater was not struck during drilling but wet gravel layers were found and resting water levels in some borehole standpipes were recorded as shallow as 0.95 m (MWS12). Some water ingress may occur where excavations intersect gravel layers and provision for dewatering is recommended.

5.3 **FLOOR SLABS**

5.3.1 For shrinkable soils, particularly where in the zone of influence of trees and hedges, it is recommended that suspended floor slabs are adopted. There are areas of the

site where shallow granular soil is present which are likely to be suitable for the adoption of ground bearing slabs.

5.4 BURIED CONCRETE

5.4.1 Recommendations given in BRE Special Digest 1:2005 "*Concrete in aggressive ground*" have been followed in order to give recommendations with respect to buried concrete.

5.4.2 Water soluble sulphate analysis was carried out on seven subsoil samples obtained from depths of between 0.45-1.80 m bgl with soil pH determination also carried out on these samples. Water soluble sulphate contents ranged between 0.0059 and 0.017 g/l. In accordance with BRE guidelines the characteristic value is calculated by determining the mean of the highest 20 % of results. In this case the characteristic value is 0.0165 g/l. On this basis the Design Sulphate Class is DS-1

5.4.3 The pH values in the soil samples varied between 6.1 and 7.2. The mean of the lowest 20 % of values is 6.15 which represents the characteristic value. Mobile groundwater conditions have been assumed and on this basis the Aggressive Chemical Environment for Concrete (ACEC) class for the site is AC-1.

5.5 ROADS AND PAVED AREAS

5.5.1 At this stage it is recommended that a CBR value of 2 % is adopted for the site. Higher values may be available in areas of shallow granular soils and it is recommended that in situ testing is undertaken for design purposes.

5.6 SOAKAWAYS

5.6.1 Permeability tests were performed in MBH1-MBH3 and the calculation sheets are included within Appendix 5. Within clay in MBH1, no significant water drops were recorded and inferred values of permeability (k) were 10^{-8} or 10^{-9} m.s⁻¹. In MBH2 in the hoggin-like material, values of 1.8×10^{-5} and 2.4×10^{-7} m.s⁻¹ were calculated with the variability likely reflecting clay content. In Chalk in MBH3, the tests recorded more favourable k values of 1.5×10^{-4} and 1.6×10^{-5} m.s⁻¹.

5.6.2 These results indicate little potential for use of soakaways in the south-east of the site. Further west, soakaways may be possible where terrace gravel strata are less clayey and providing a shallow water table is absent. Here suitable ground conditions at individual soakaway locations would need to be confirmed by targeted trial pit investigation. In the chalk, which despite being recovered in boreholes as predominantly silt matrix, the permeability test results suggest good rates of infiltration would be available in the north-east of the site. However, fairly deep soakaways would be required where chalk is overlain by superficial deposits and if highly weathered putty chalk persists. Soakaways should be located at a suitable distance from structures in areas underlain by soluble strata.

5.6.3 Anecdotally, it is understood the golf course uses soakaways which, from the descriptions, suggest informally designed rubble filled pits.

5.6.4 For design purposes, soakage test pits would be required.

SECTION 6 ENVIRONMENTAL ASSESSMENT

6.1 SOIL QUALITY

6.1.1 A total of 10 soil samples were submitted to the laboratory for chemical analysis, including five samples from topsoil, three samples from natural subsoil and two samples of the surface made ground. The laboratory chemical analysis certificates are contained in Appendix 4. The results of the analysis are summarised in Table 6.

6.1.2 An initial screening exercise has been undertaken whereby contaminant concentrations recorded in soils have been assessed against *Suitable for Use Levels* (S4ULs) published in 2015 by LQM/CIEH¹. These precautionary screening levels are designed to be representative of minimal risk to human health in a number of land use scenarios. In this report S4ULs have been selected for a residential land use where the possibility of consumption of homegrown produce exists and, conservatively applying a soil organic matter of 1 %. For lead the DEFRA Category 4 Screening Level² has been used as this is based on updated toxicological data and a low risk to human health.

6.1.3 An additional set of phytotoxin screening levels have been adopted from 'The Code of Agricultural Practice for the Protection of Soil' Ministry of Agriculture, Fisheries and Food (MAFF), 1993, which are protective of healthy plant growth.

Table 6: Summary of Soils Chemical Analysis Results

CONTAMINANT	UNITS	MIN	MAX	No of Tests	SCREENING LEVEL (SL)	No > SL*
HUMAN HEALTH RISK ASSESSMENT						
Asbestos in soil	-	NAD	NAD	2	Detected	0
pH	-	5.1	7.2	15	5 – 9	0
Arsenic	mg.kg ⁻¹	9	26	10	37	0
Cadmium	mg.kg ⁻¹	<0.2	<0.2	10	11	0
Chromium (total)	mg.kg ⁻¹	15	34	10	910	0
Lead	mg.kg ⁻¹	8.9	49	10	200	0
Mercury	mg.kg ⁻¹	<0.3	<0.3	10	40	0
Nickel	mg.kg ⁻¹	11	29	10	130	0

¹ Nathanail, C. P., McCaffrey, C., Gillett, A. G., Ogden, R. C. and Nathanail, J. F. 2015. *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press, Nottingham. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3100. All rights reserved. Including August 2015 nickel update.

² SP1010 *Development of Category 4 Screening Levels Main Report* (Dec 2013) and SP1010 *Policy Companion Document* (Mar 2014).

CONTAMINANT	UNITS	MIN	MAX	No of Tests	SCREENING LEVEL (SL)	No > SL*
HUMAN HEALTH RISK ASSESSMENT						
Selenium	mg.kg ⁻¹	<0.1	3.4	10	250	0
TPH C10-C40	mg.kg ⁻¹	<10	28	10	-	-
Acenaphthene	mg.kg ⁻¹	<0.05	<0.05	10	210	0
Acenaphthylene	mg.kg ⁻¹	<0.05	<0.05	10	170	0
Anthracene	mg.kg ⁻¹	<0.05	<0.05	10	2400	0
Benz(a)anthracene	mg.kg ⁻¹	<0.05	<0.05	10	7.2	0
Benzo(a)pyrene	mg.kg ⁻¹	<0.05	<0.05	10	2.2	0
Benzo(b)fluoranthene	mg.kg ⁻¹	<0.05	<0.05	10	2.6	0
Benzo(ghi)perylene	mg.kg ⁻¹	<0.05	<0.05	10	320	0
Benzo(k)fluoranthene	mg.kg ⁻¹	<0.05	<0.05	10	77	0
Chrysene	mg.kg ⁻¹	<0.05	<0.05	10	15	0
Dibenz(ah)anthracene	mg.kg ⁻¹	<0.05	<0.05	10	0.24	0
Fluoranthene	mg.kg ⁻¹	<0.05	0.3	10	280	0
Fluorene	mg.kg ⁻¹	<0.05	<0.05	10	170	0
Indeno(123-cd)pyrene	mg.kg ⁻¹	<0.05	<0.05	10	27	0
Naphthalene	mg.kg ⁻¹	<0.05	<0.05	10	2.3	0
Phenanthrene	mg.kg ⁻¹	<0.05	<0.05	10	95	0
Pyrene	mg.kg ⁻¹	<0.05	0.31	10	620	0
PHYTOTOXICITY RISK ASSESSMENT						
	Units	Max	Mean	No of Test	Screening Level (SL)	No > SL
Copper	mg.kg ⁻¹	7.4	22	10	200	0
Nickel	mg.kg ⁻¹	11	29	10	110	0
Zinc	mg.kg ⁻¹	27	60	10	300	0

Notes: * Number of samples exceeding screening level

nd = not detected

6.1.4 Zootoxic Metals (harmful to human health)

6.1.4.1 None detected above their respective screening levels.

6.1.5 Phytotoxic Metals (harmful to plant health)

6.1.5.1 None detected above their respective screening levels.

6.1.6 Organic Contaminants

6.1.6.1 None detected above their respective screening levels. The priority 16 PAHs were mostly undetected.

6.1.6.2 For petroleum hydrocarbons, a total screen analysis was employed. However, the maximum concentrations did not exceed any of the screening levels derived for individual aliphatic and aromatic fractions.

6.1.7 Inorganic Contaminants

6.1.7.1 No asbestos fibres were detected within the two made ground samples analysed.

6.2 HAZARDOUS GAS

6.2.1 Gas monitoring has been undertaken on one occasion – 06 November 2019. Levels of methane, carbon dioxide and oxygen were recorded in each standpipe, together with associated parameters including borehole flow and ambient air pressure. The results of the gas monitoring round are contained in Appendix 6.

6.2.2 The monitoring was undertaken at barometric pressures ranging from 994 to 995 mb. Peak positive flow was recorded in the two standpipes (MWS9 and MWS12) both of which were found to contain water. This dissipated to undetectable flow in MWS9 but remained steady at 3.0 litres/hour in MWS12. However, based on the ground conditions pressure driven flow caused by gas generation is unlikely. Methane (CH₄) was not detected in any standpipe, carbon dioxide (CO₂) was detected to a maximum of 4.1 % v/v with a corresponding depleted oxygen concentration of 15.3 % v/v.

6.3 WASTE CLASSIFICATION, OFF-SITE DISPOSAL OR RE-USE

6.3.1 Waste Considerations

6.3.1.1 Using the WM3 waste assessment guidance, the soil analysis would indicate that arisings disposed of as waste would be classed as non-hazardous. It is anticipated that natural soil arisings would also be suitable for disposal at inert licensed landfill facilities.

6.3.1.2 Natural as-dug arisings (excluding topsoil) could be classed as inert waste without the requirement for WAC testing.

6.3.1.3 Materials, including waste soils which are not to be retained on site, should be removed and disposed of in accordance with all relevant statutes including the *Environmental Protection Act 1990* as amended, *The Controlled Waste Regulations 2012* as amended, *The Waste Regulations 2011* as amended, *The Hazardous Waste Regulations 2005* as amended, *The Waste Management Regulations 2006*, *The Environmental Permitting Regulations 2010* as amended and *The Hazardous Waste (Miscellaneous Amendments) Regulations 2015*.

6.3.1.4 It is a requirement of these regulations that waste sent to landfill should have been subject to measures to reduce the amount of waste, reduce harmful or hazardous properties and facilitate recycling. These requirements may be satisfied by measures such as segregation and screening of wastes to recover suitable fill and material for crushing, segregation of inert materials and putrescible wastes.

6.3.2 Re-use Considerations

6.3.2.1 As a sustainable alternative to off-site disposal, it may be possible to re-use site-won soils provided the following criteria are met:

- i.* Use of the material will not create an unacceptable risk of pollution to the environment or harm to human health;
- ii.* The material must be chemically and geotechnically suitable without further treatment;
- iii.* There must be certainty of use within the scheme;
- iv.* Material should only be used in the quantity necessary for that use.

6.3.2.2 Provided these criteria are met, the re-use of site-won materials is unlikely to be deemed a waste activity. Production of a *Materials Management Plan* under the industry *CL:AIRE Code of Practice on the Definition of Waste* represents a robust method of demonstrating that the proposed re-use of material meets the criteria and is not liable for landfill tax.

SECTION 7 RISK ASSESSMENT

- 7.1 The potential sources of contamination at the site and the implications with respect to development have been interpreted in accordance with the current government guidance on source-pathway-receptor risk assessment.
- 7.2 The investigations have not found significant soil contamination however it is noted that in the immediate club house vicinity made ground deposits are likely to be present, particularly after demolition, which may contain higher levels of contamination than those found over the bulk of the site. These ground conditions identified to date are considered for their potential to act as sources for a number of pollutant linkages.
- 7.3 The potential impacts of contamination sources have been considered with respect to the following receptors:
 - i.* The general public and present site users,
 - ii.* Residents of future development,
 - iii.* Groundwater,
 - iv.* Surface water,
 - v.* Construction workers,
 - vi.* Adjacent land, and
 - vii.* Infrastructure.
- 7.4 In each case the existence of a pollutant linkage requires a pathway by which the receptor could be exposed to the source. A qualitative assessment of risk is thus considered in the first instance with respect to the site in its current condition and is summarised in the sections below.

7.5 The general public and present site users

7.5.1 No risk identified.

7.6 Residents of future development

7.6.1 Soil contamination (chemical)

7.6.1.1 No risk identified. However, under the clubhouse area, made ground may be present which could contain contaminants. Also if existing buildings have been subject to redevelopment or extension, the presence of asbestos containing materials cannot be discounted.

7.6.2 Hazardous Soil Gas/Vapours (including hydrocarbon vapours/radon)

7.6.2.1 No risks of significant gas ingress into dwellings has been identified from the investigation. The gas screening value derived from the data obtained to date, is consistent with an NHBC GREEN condition.

7.6.2.2 Additional monitoring is ongoing.

7.7 Controlled waters

7.7.1 No risk identified.

7.8 Construction workers

7.8.1 Potentially, construction workers are initially at the greatest risk from exposure to contamination due to excavation works and during the handling of materials including imported soils. Providing that dust levels are kept within statutory limits and appropriate health and safety procedures are adhered to during the construction phase, the levels of chemical contamination recorded to date are not considered to present an acute risk to human health.

7.9 Adjacent land

7.9.1 Surrounding land uses appear to have been largely residential and no risks from off site sources have been identified. Similarly, the site is not likely to pose a risk to adjacent land users.

7.10 Infrastructure

7.10.1 Phytotoxic contaminants which can inhibit plant growth have not been detected at significant levels.

7.10.2 Contamination with the potential to permeate polymeric services has not been identified by this investigation, however it is recommended that the utility provider is consulted with respect to their requirements for water supply pipes.

- 7.10.3 Utility companies apply strict guideline levels on use of polymeric pipes and may consider all made ground unsuitable for typical plastic pipe materials to be used.

SECTION 8 UPDATED CONCEPTUAL MODEL

- 8.1 Following completion of phases 1 and 2 of the investigation and a qualitative risk assessment, the conceptual model for the site, with relation to pollutant linkages, has been updated. The revised model is presented in Table 7 below.

Table 7: Revised Conceptual Model

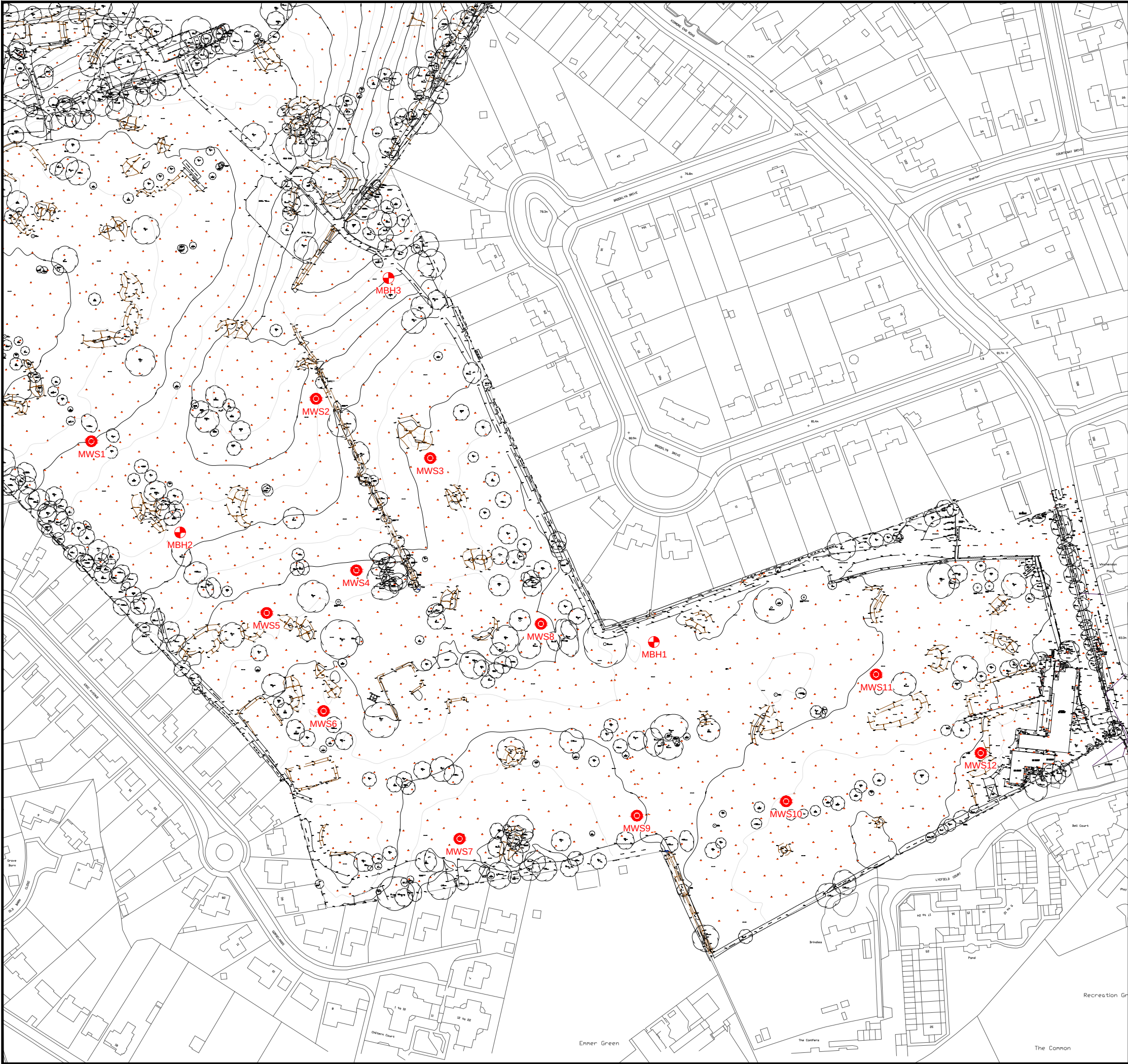
POSSIBLE POLLUTANT LINKAGE			RISK CHARACTERISATION
POTENTIAL SOURCES	PATHWAYS	RECEPTORS	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (current users)	No risk identified Ground conditions found to be substantially natural.
	Ingestion and inhalation of contaminated soil and dust	Human health (current users)	
Heavy metals and hydrocarbons (made ground)	Contact with contaminated soil	Human health (future residents and construction workers)	No risk identified Ground conditions found to be substantially natural. However possible made ground under and in vicinity of club house.
	Ingestion and inhalation of contaminated soil and dust	Human health (future residents and construction workers)	
Asbestos (made ground)	Ingestion and inhalation of contaminated soil and dust	Human health (future residents and construction workers)	Low risk identified None identified. Potential for made ground to contain asbestos from demolition of club buildings
Contamination (all forms)	Vertical migration to aquifer	Controlled waters	No risk identified Presence of shallow gravel and chalk aquifer receptors but very low contamination found so far.
Contamination (all forms)	Horizontal migration to surface water	Controlled waters	No risk identified No surface waters in the vicinity
Hydrocarbons	Direct contact	Plastic water pipes	Low risk identified No risk identified over majority of the site but cannot rule out presence of localised shallow hydrocarbon contamination at this stage.
Hazardous Gas/Vapours In soil	Ingress into buildings and voids	Human health (future residents and construction workers)	Low risk identified Significant sources of gas generation have not been identified. Monitoring to date has not found gas likely to ingress into dwellings to hazardous levels.
Adjacent Land	Dust, groundwater migration, surface run-off and gas migration	Human health (current and future users)	No risk identified No significant sources found.

SECTION 9 PRELIMINARY REMEDIATION STRATEGY

- 9.1 The identified risks at the site can be mitigated by removal of either the source, pathway or receptor. With reference to the conceptual model for the site a remediation strategy, based on source or pathway removal, has been designed.

- 9.2 No remedial actions are identified at this time. However, when the site becomes available, further investigation in and around the built area should be undertaken to confirm the presence of made ground and associated contaminants. This would be be suited to post-demolition trial pits.
- 9.3 It is anticipated that site-won topsoil will be used for the formation of domestic gardens and landscaped areas. This should be handled in accordance with current good practice guidelines and where made ground is found, it should be kept separate from natural topsoil.
- 9.4 Significant risks to construction workers have not been identified but as with all sites, the adoption of appropriate Health and Safety procedures will ensure that hazards from materials handling are minimised. Operatives should not be allowed to eat, drink or smoke on site except in designated areas and should be required to wash all exposed skin at the end of each shift. Operatives should be informed of the potential hazards at the site and should be required to report any observations of suspect material.
- 9.5 Materials, including waste soils which are not to be retained on site, should be removed and disposed of in accordance with all relevant statues including the *Environmental Protection Act 1990* as amended, *The Controlled Waste Regulations 2012* as amended, *The Waste Regulations 2011* as amended, *The Hazardous Waste Regulations 2005* as amended, *The Waste Management Regulations 2006*, *The Environmental Permitting Regulations 2010* as amended and *The Hazardous Waste (Miscellaneous Amendments) Regulations 2015*.
- 9.6 It is recommended that this report is submitted to the regulators (Local Authority EHO and Planners, Environment Agency Planning Liaison and NHBC) for approval prior to commencement of the works.
- 9.7 Any observations of ground conditions atypical of those already described should be reported to IDOM immediately so that an assessment of appropriate action can be made.

APPENDIX 1 ▪ Drawings



Legend

-  Cable percussion drilled borehole with reference
-  MBHref
-  Dynamic sampler/windowless sample drilled borehole with reference
-  MWSref

First Issue	23-09-2019		-
	FDO	KRP	KRP
Issue Details	Dwn	Chd	App'd
Client/Project			
Redrow Homes Thames Valley Reading Golf Club			
Dwg Title			
Approximate Exploratory Hole Locations			
Job No.	Dwg No.	Revision	
21962b	304-001	-	
Scale	Date	Frame Dimensions mm	
N.T.S	September 2019	(A3) 400 x 280	
Drawn	Checked	Approved	
FDO	KRP	KRP	

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APPENDIX 2 ▪ Historical Plans

Site Details:

READING GOLF CLUB, 17,
KIDMORE END ROAD, EMMER
GREEN, READING, RG4 8SQ

Client Ref: 19-S1093-FDO-21962b
Report Ref: HMD-154-6398304
Grid Ref: 471630, 176854

Map Name: County Series

Map date: 1878

Scale: 1:10,560

Printed at: 1:10,560



Surveyed 1878
Revised 1878
Edition N/A
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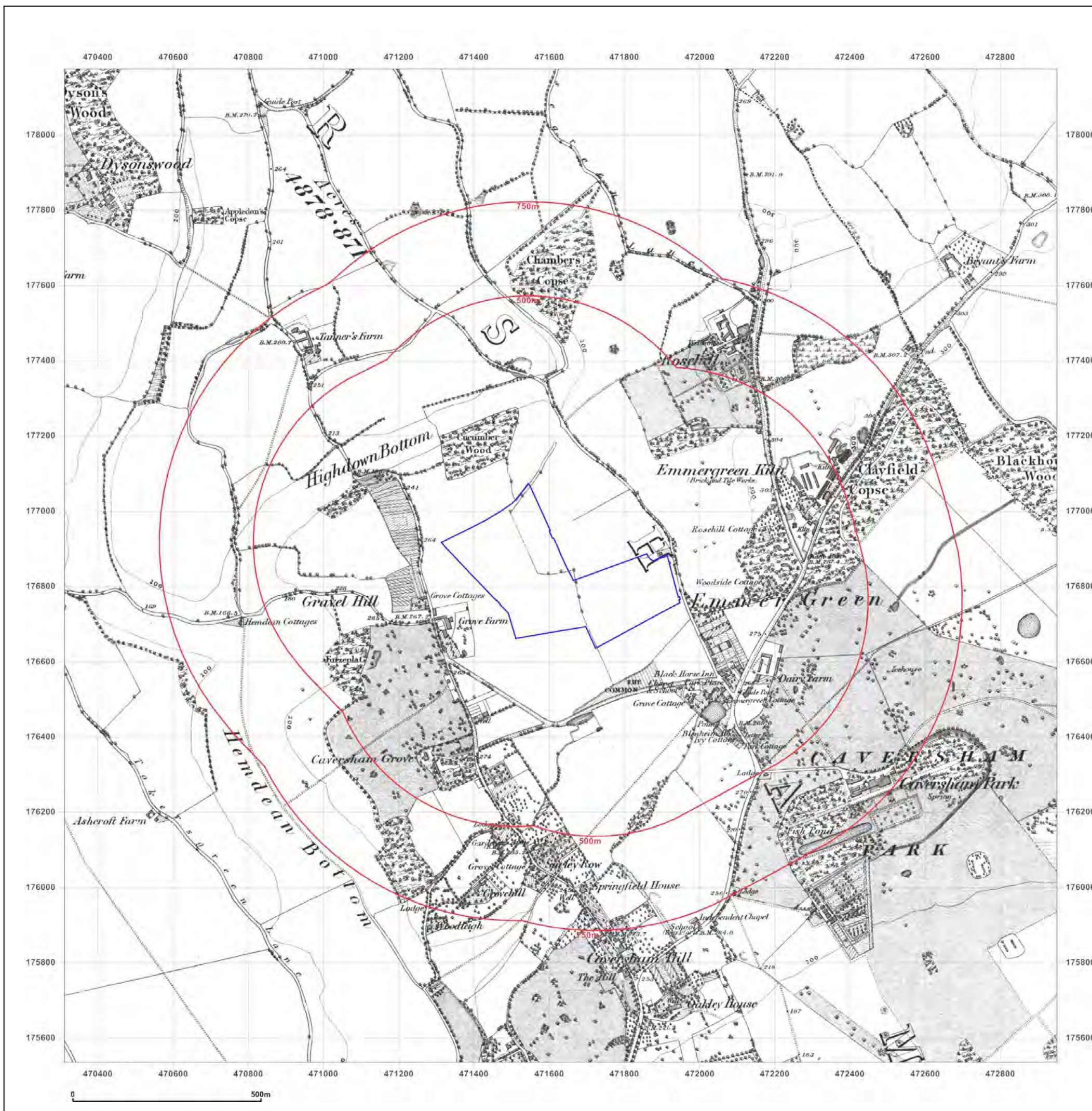


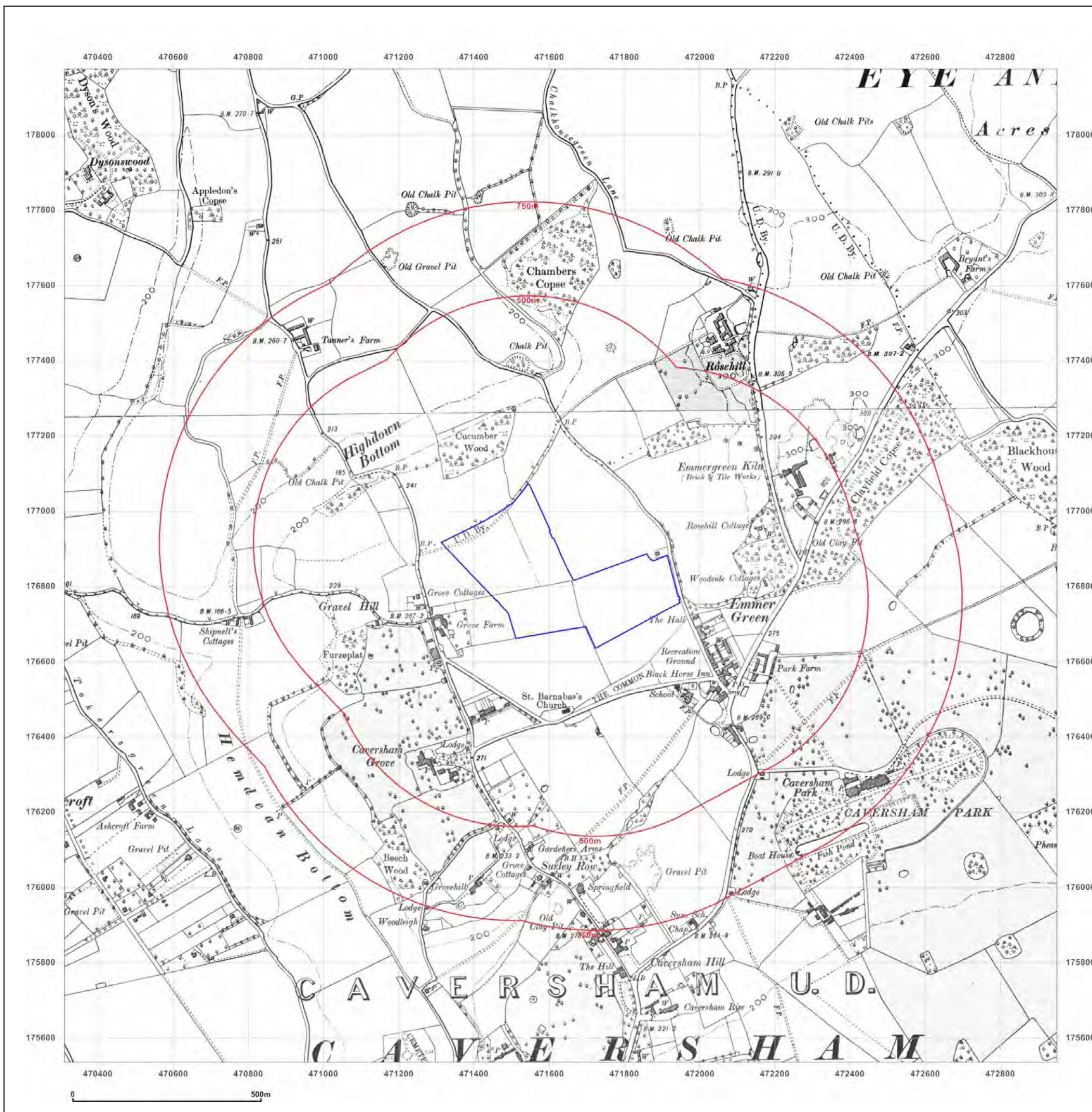
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Map Name: County Series

Map date: 1897-1900

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Surveyed 1877
Revised 1897
Edition N/A
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Grid Ref: 471630, 176854

Map Name: County Series

Map date: 1910

Scale: 1:10,560

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Edition N/A
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Surveyed 1877
Revised 1910
Edition N/A
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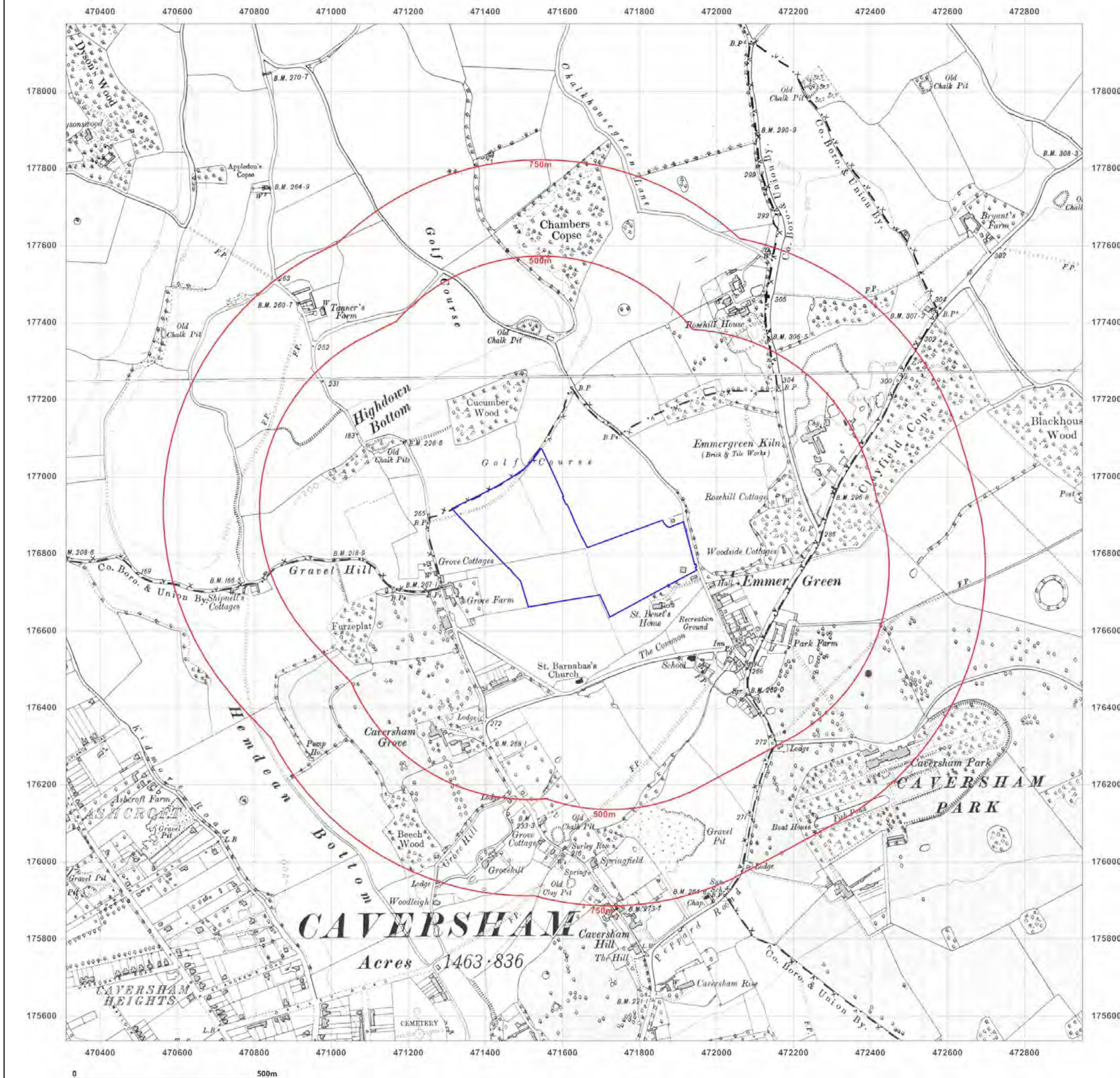


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Map Name: County Series

Map date: 1914-1915

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Revised 1910
Edition 1914
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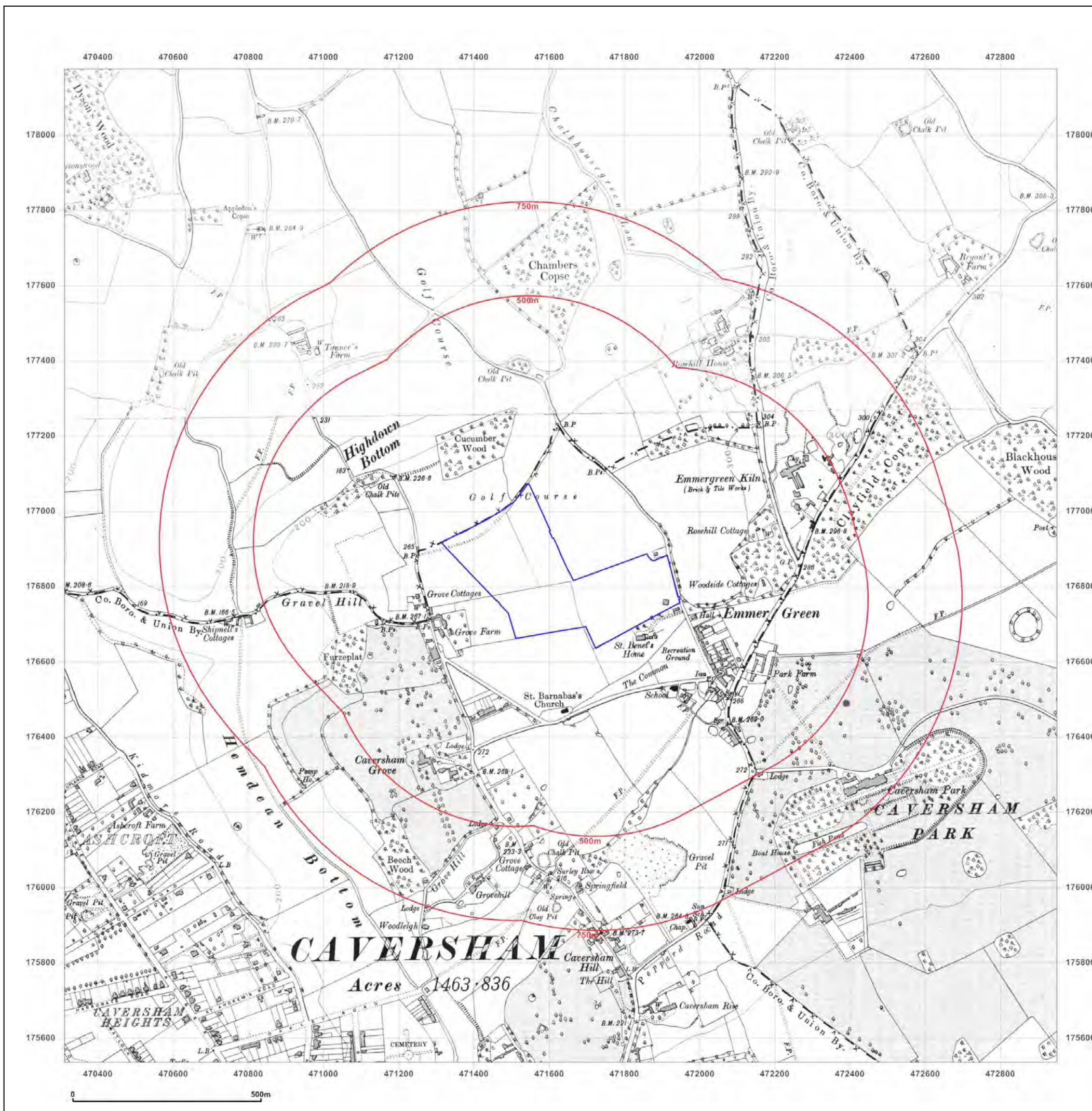


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Map Name: County Series

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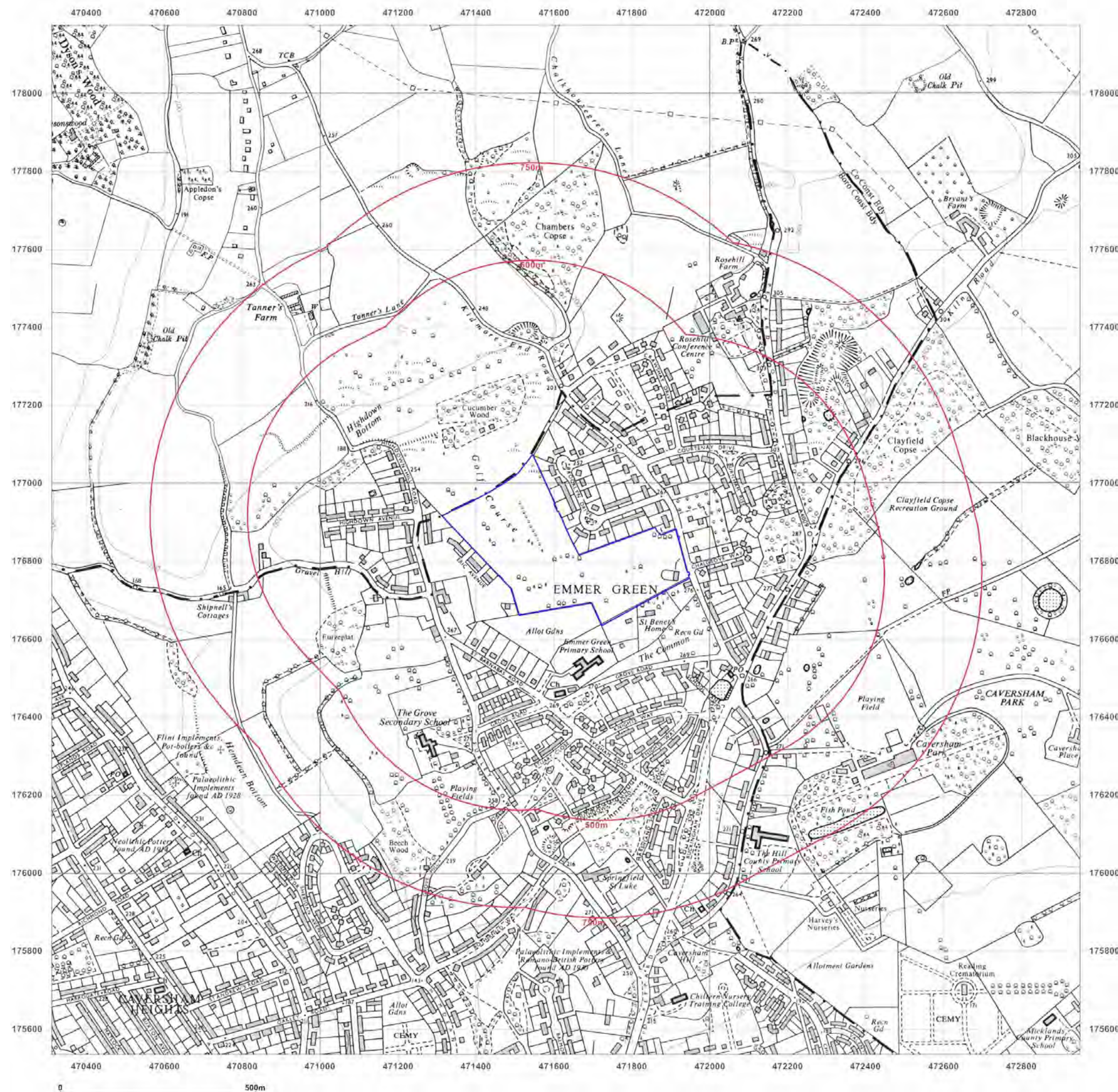


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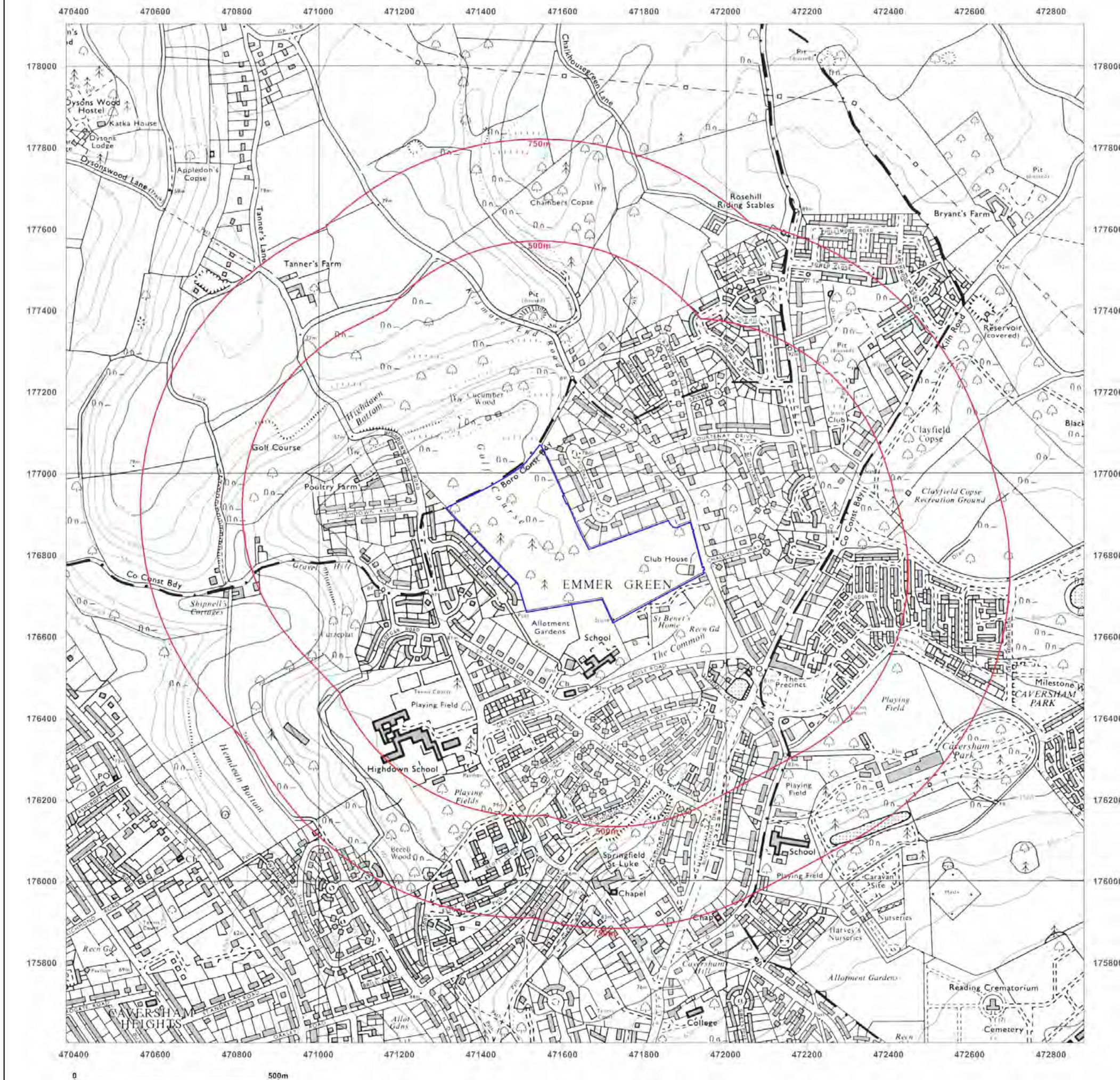


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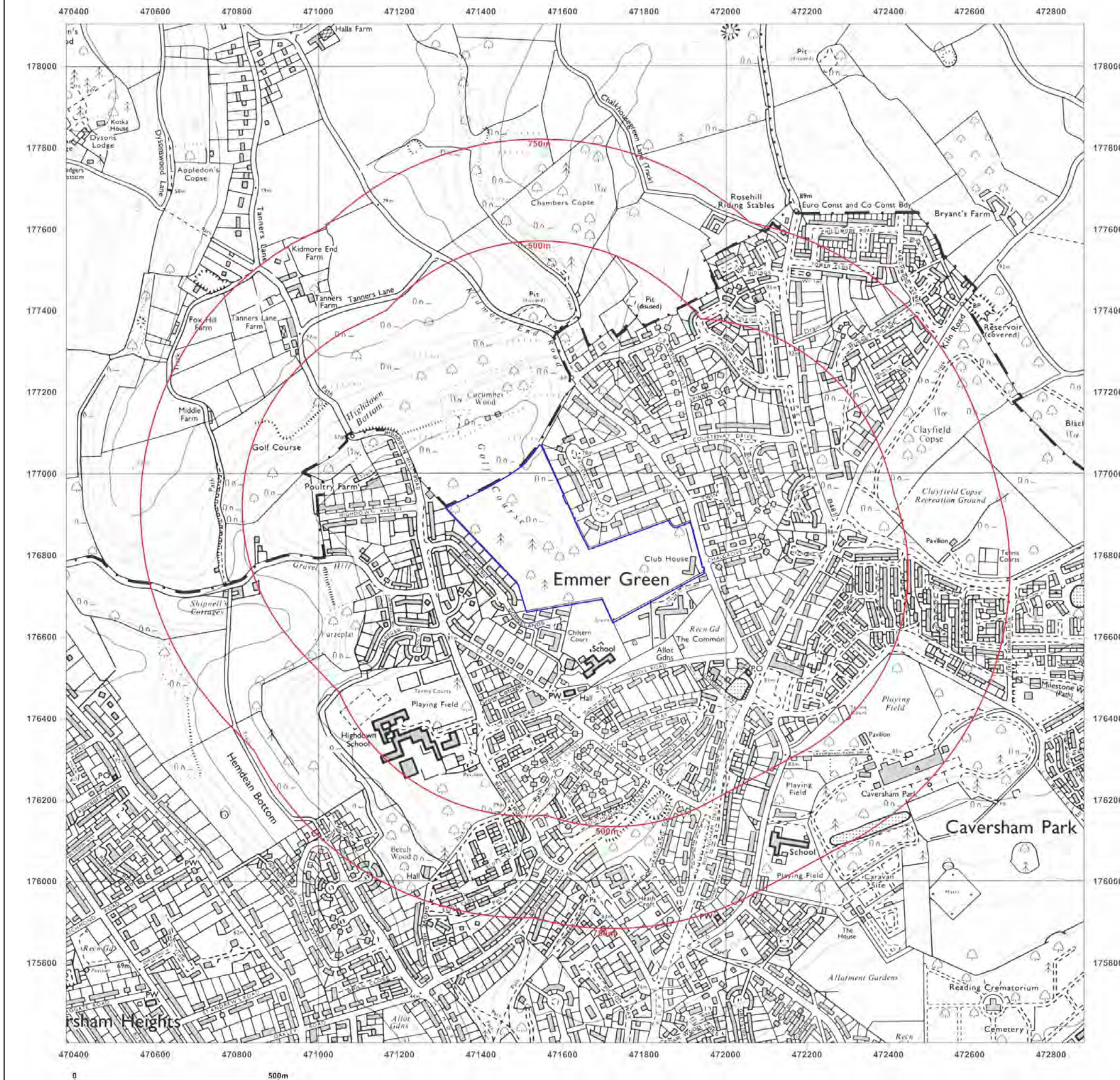


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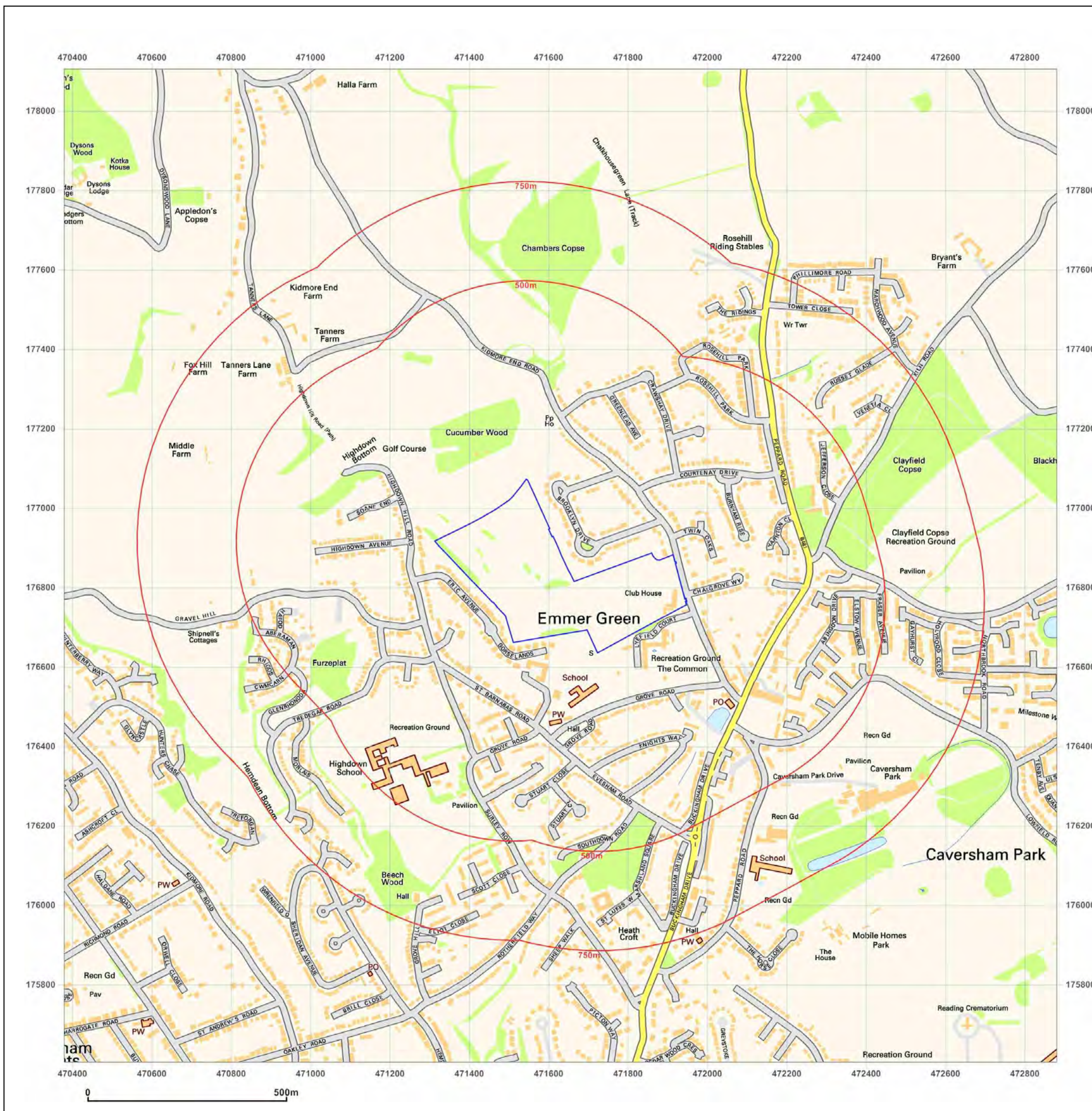


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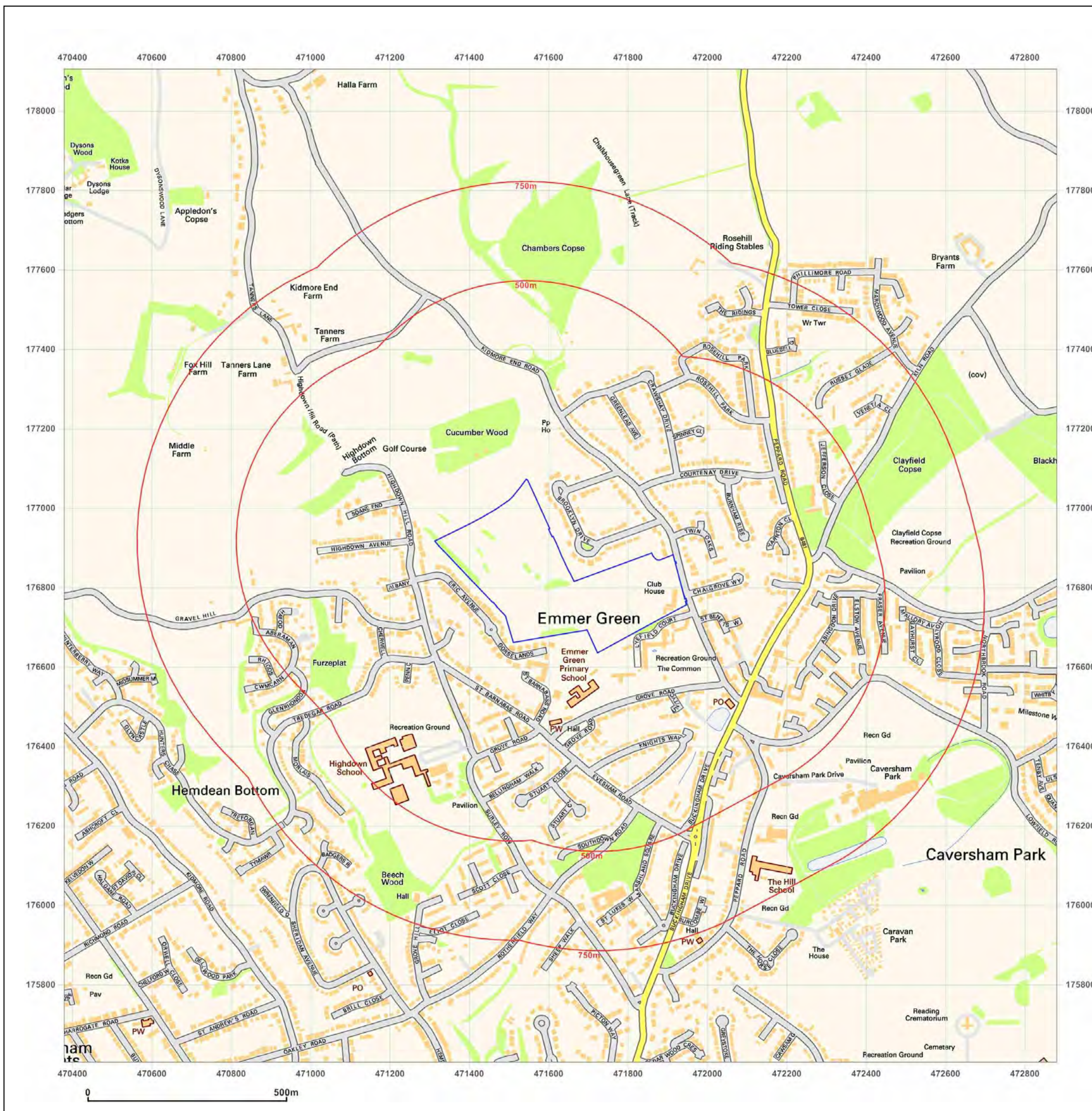


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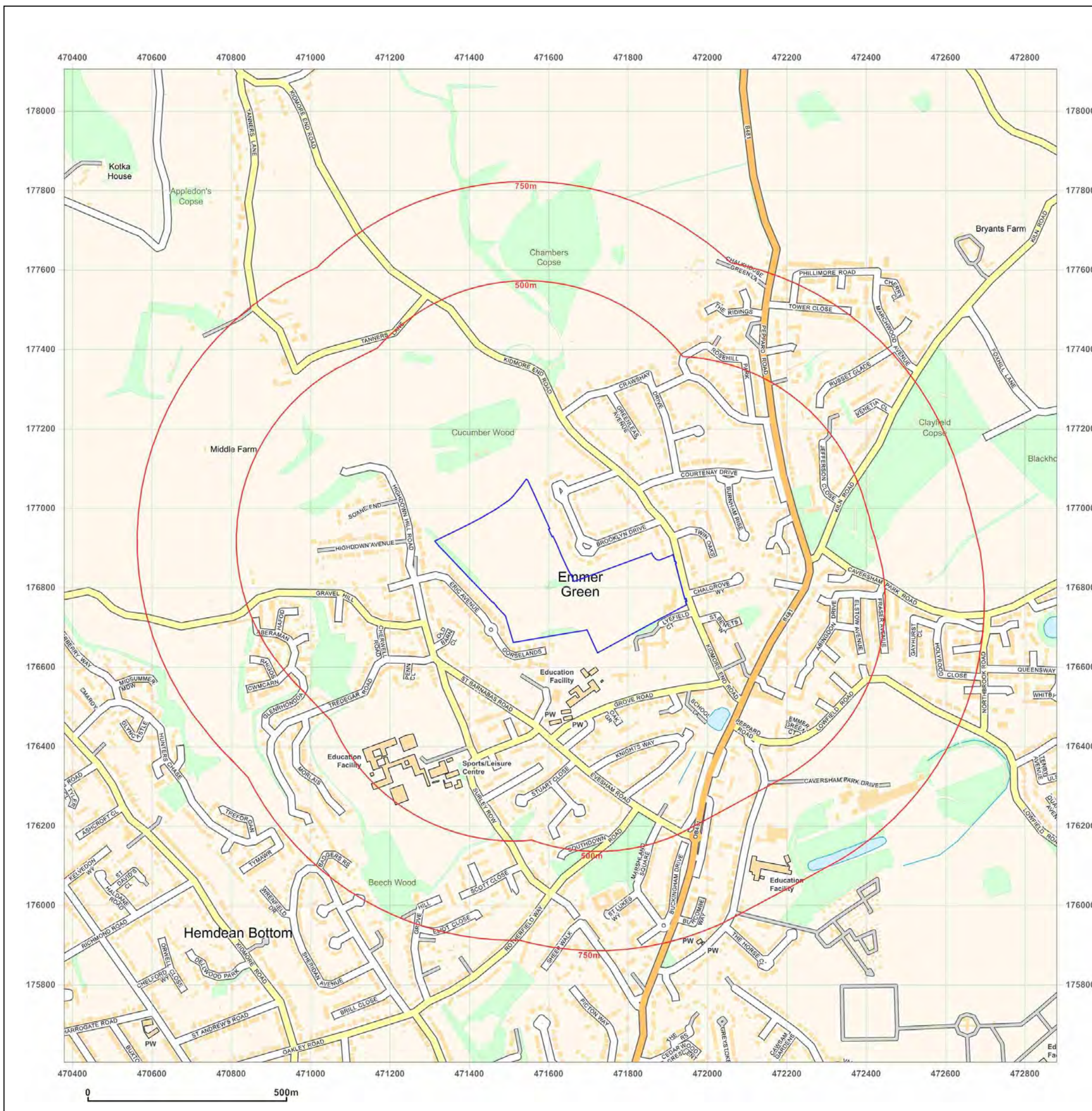


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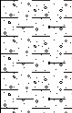
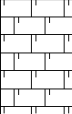
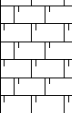
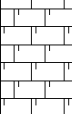
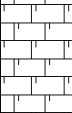
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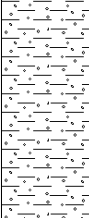
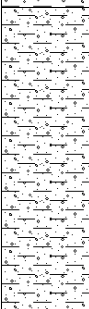
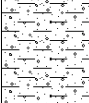
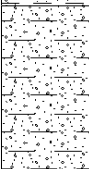
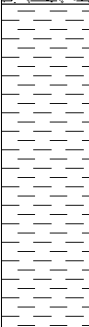


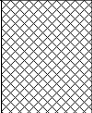
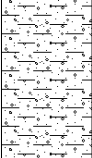
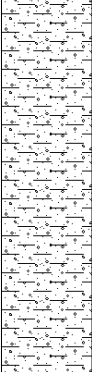
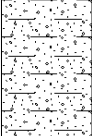
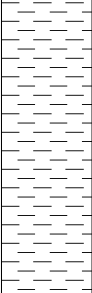
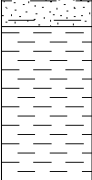
APPENDIX 3

- Exploratory Hole Logs
- BGS Borehole Log SU77NW68

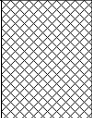
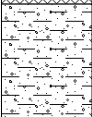
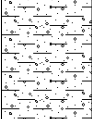
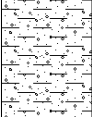
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												MBH3	
												Sheet 1 of 1	
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Location:									Level (m):			Scale 1:50	
Equipment: Dando 2000 Mark 2									Dates: 16/10/2019			Logged By Driller/KP	
Well	Wtr Strk	Sample and In Situ Testing			Coring				Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results	FI	TCR	SCR	RQD					
									0.40			Grass over dark brown gravelly loam TOPSOIL.	
		1.00	D						1.20		Firm to stiff rusty brown sandy very gravelly CLAY/very clayey sandy GRAVEL. Gravel is medium angular flint.	1	
		1.20	SPT(C)	N=30 (3,5/8,12,6,4)									
		2.00	D						2.00		Creamy-brown becoming ff white CHALK, recovered as 80% silt with some sub-angular chalk gravel and occasional gravel sized flint fragments.	2	
		2.00	SPT(C)	N=11 (6,7/3,3,2,3)									
		3.00	D						3.00			3	
		3.00	SPT(C)	N=15 (2,3/4,4,3,4)									
		4.00	D						4.00			4	
		4.00	SPT(C)	N=17 (3,5/6,3,3,5)									
		5.00	D						5.00			5	
5.00	SPT(C)	N=21 (2,4/5,8,4,4)											
6.00	D						6.50			6			
6.50	SPT(C)	N=17 (9,12/6,4,4,3)											
7.00	D						8.00			7			
8.00	SPT(C)	N=17 (3,4/5,5,3,4)											
								8.45			End of Borehole at 8.45m	8	
												9	
												10	
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm) FI = fracture index TCR = total core recovery SCR = solid core recovery RQD = rock quality designation									Remarks Service clearance pit to 1.20m. Hole backfilled with arisings.				

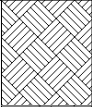
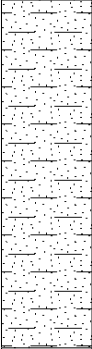
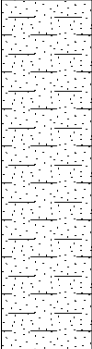
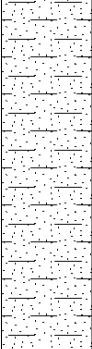
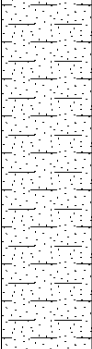
						Windowless Sample Log		Borehole No. MWS1 Sheet 1 of 1	
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS	
Location:						Level (m):		Scale 1:25	
Equipment: Premier Compact 110 Series						Dates: 15/10/2019		Logged By CEK	
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.20	D,J		0.20		 TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1	
		0.10 - 0.20	D,J						 Brown slightly fine sandy gravelly CLAY. Gravel is fine to medium chert. Rootlets common.
		0.45 - 0.55	D		0.55		 Beige silty fine sandy GRAVEL of fine to coarse subrounded to subangular chert.		
		1.00	SPT(C)						N=34 (10,11/10,10,7,7)
		2.00	SPT(C)	N=20 (3,6/6,6,4,4)	2.50		 Orange clayey fine sandy GRAVEL of fine to coarse subrounded to subangular chert.		
3.00	SPT(C)	N=20 (7,7/6,6,3,5)	3						
4.00	SPT(C)	N=16 (4,4/4,4,4,4)			4				
5.00	SPT(C)	N=39 (7,7/10,10,10,9)	5.00						
							End of Borehole at 5.00m		
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample							SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)		
Remarks									

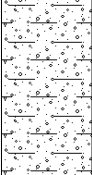
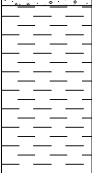
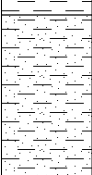
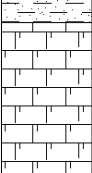
						Windowless Sample Log		Borehole No. MWS10 Sheet 1 of 1			
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS			
Location:						Level (m):		Scale 1:25			
Equipment: Premier Compact 110 Series						Dates: 16/10/2019		Logged By CEK			
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.10 - 0.20	D,J		0.20		 TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1			
							 Brown very gravelly CLAY. Gravel is fine to coarse rounded to angular chert.				
		1.00	SPT(C)	N=20 (4,4/5,5,5,5)	0.95		 Orange fine sandy gravelly CLAY. Fine to coarse rounded to sangular chert gravel.	2			
							 Mottled black.				
		2.00	SPT(C)	N=31 (6,6/5,6,10,10)	2.30		 Orangish brown clayey slightly gravelly fine to medium SAND. Fine subrounded chert gravel.				
						 Greyish brown mottled red CLAY.	3				
3.00	SPT(C)	N=22 (2,2/4,5,5,8)	2.85								
		4.00	SPT(C)	N=7 (1,1/2,1,2,2)	3.95 4.00		 Orange coarse sandy fine rounded to subrounded chert GRAVEL. Very wet.	4			
						End of Borehole at 4.00m					
									5		
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)				Remarks	

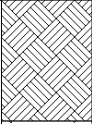
						Windowless Sample Log		Borehole No. MWS11 Sheet 1 of 2			
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS			
Location:						Level (m):		Scale 1:25			
Equipment: Premier Compact 110 Series						Dates: 16/10/2019		Logged By CEK			
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.10 - 0.30	D,J		0.40			MADE GROUND. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel and occasional fine to medium gravel sized brick fragments. Grass topped with rootlets throughout.	1		
								Orange fine to medium sandy gravelly CLAY. Gravel is fine to coarse subangular chert.			
		1.00	SPT(C)	N=32 (6,7/5,7,10,10)	2.20			Orange clayey gravelly fine to medium SAND. Gravel is fine to coarse subangular chert.	2		
		2.00	SPT(C)	N=24 (7,7/6,6,6,6)							
								Grey CLAY.			
		3.00	SPT(C)	N=17 (2,4/4,3,5,5)	3.80			Grey mottled black clayey SAND.	3		
								Grey CLAY.			
		4.00	SPT(C)	N=41 (2,4/10,10,10,11)							
					4.50			Grey mottled red brown and yellow clayey medium SAND.	4		
								End of Borehole at 4.50m			
									5		
								Continued on Next Sheet			
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)				Remarks	

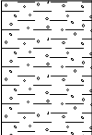
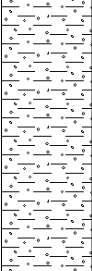
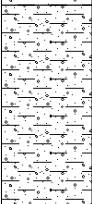
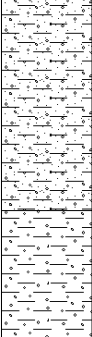
IDOM					Windowless Sample Log		Borehole No. MWS11 Sheet 2 of 2				
Project Name: Reading Golf Club			Project No. 21962B		Co-ords:		Hole Type WLS				
Location:					Level (m):		Scale 1:25				
Equipment: Premier Compact 110 Series					Dates: 16/10/2019		Logged By CEK				
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		5.00	SPT(C)	N=32 (10,13/10,10,6,6)							
									6		
									7		
									8		
									9		
									10		
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample					SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)					Remarks	

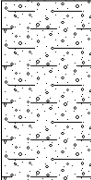
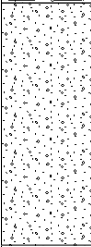
						Windowless Sample Log		Borehole No. MWS12 Sheet 1 of 1	
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS	
Location:						Level (m):		Scale 1:25	
Equipment: Premier Compact 110 Series						Dates: 16/10/2019		Logged By CEK	
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.30	D,J		0.40			MADE GROUND. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel and occasional fine to medium gravel sized brick fragments. Grass topped with rootlets throughout.	1
		0.80 - 0.90	D,J					Brownish orange slightly medium sandy very gravelly CLAY. Subangular chert gravel.	
		1.00	SPT(C)	N=20 (7,5/4,6,5,5)	1.80			Orange mottled beige slightly clayey slightly gravelly fine to medium SAND. Gravel is fine to medium subrounded chert. Very wet at depth.	2
		2.00	SPT(C)	N=22 (2,2/5,5,6,6)					
		2.50	SPT(C)	0 (17 for 75mm/0 for 0mm)	2.50		End of Borehole at 2.50m		3
3.00	SPT(C)	0 (17 for 75mm/0 for 0mm)					4		
									5
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)			
Remarks									

						Windowless Sample Log		Borehole No. MWS2 Sheet 1 of 1	
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS	
Location:						Level (m):		Scale 1:25	
Equipment: Premier Compact 110 Series						Dates: 15/10/2019		Logged By CEK	
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.35		 TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.		
		0.80 - 1.00	D,J				 Orange (mottled brown in upper 20 cm) clayey medium SAND with occasional rootlets.	1	
		1.00	SPT(C)	N=30 (10,8/8,8,7,7)					
					1.50		 Orange slightly clayey fine SAND.	2	
		2.00	SPT(C)	N=17 (4,4/4,5,4,4)					
		2.80 - 2.90	D				 Greyish orange here with fine to medium sub angular flint gravel.	3	
		3.00	SPT(C)	N=12 (3,3/3,3,3,3)					
		4.00	SPT(C)	N=32 (1,2/2,10,10,10)			 End of Borehole at 5.00m	4	
		5.00	SPT(C)	N=18 (2,3/4,4,5,5)	5.00			5	
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)		Remarks	

						Windowless Sample Log		Borehole No. MWS3 Sheet 1 of 1			
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS			
Location:						Level (m):		Scale 1:25			
Equipment: Premier Compact 110 Series						Dates: 15/10/2019		Logged By CEK			
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		1.00	SPT(C)	N=6 (5,4/3,1,1,1)	0.20			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1		
					0.40			Greyish brown gravelly CLAY. Gravel is subrounded to subangular fine to medium chert.			
					0.70			Orange clayey slightly medium sandy GRAVEL. Gravel is subrounded to subangular fine to medium chert.			
								Orange slightly clayey fine to medium sandy GRAVEL. Gravel is subrounded to subangular fine to medium chert.			
		1.70 - 1.80	D		1.40			Grey mottled orange CLAY.		2	
		2.00	SPT(C)	N=4 (1,1/1,1,1,1)	2.00			Greyish orange slightly medium sandy CLAY.			
		3.00	SPT(C)	N=36 (1,1/4,6,13,13)	2.60			White mottled orangish grey structureless CHALK. Occasional medium to coarse subangular to subrounded chert.			3
		3.50 - 3.70	D								
		4.00	SPT(C)	N=21 (4,5/5,4,6,6)	4.00			End of Borehole at 4.00m		4	
											5
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)					
						Remarks					

						Windowless Sample Log		Borehole No. MWS4 Sheet 1 of 1				
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS				
Location:						Level (m):		Scale 1:25				
Equipment: Premier Compact 110 Series						Dates: 15/10/2019		Logged By CEK				
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description				
		Depth (m)	Type	Results								
		0.80 - 1.00	D,J	N=45 (7,10/10,12,13,10)	0.40			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1			
					0.50			Brownish orange gravelly CLAY. Gravel is medium to coarse angular chert.				
								Brownish orange slightly gravelly CLAY. Gravel is medium to coarse angular chert.				
												
		1.00	SPT(C)		1.00			Multicoloured medium to coarse sandy GRAVEL. Gravel is fine to coarse angular chert.				
					1.50			Multicoloured gravelly CLAY. Gravel is fine to coarse angular chert.				
		2.00	SPT(C)	N=50 (10,10/50 for 275mm)	1.80			Multicoloured medium to coarse sandy GRAVEL. Gravel is fine to coarse angular chert.				
					2.00			End of Borehole at 2.00m				
												2
												3
								4				
								5				
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)				Remarks		

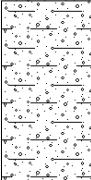
						Windowless Sample Log		Borehole No. MWS5 Sheet 1 of 1			
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS			
Location:						Level (m):		Scale 1:25			
Equipment: Premier Compact 110 Series						Dates: 15/10/2019		Logged By CEK			
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.00 - 0.20	D,J		0.30			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1		
		0.80 - 0.90	D,J					Orangish brown very gravelly clay. Fine to coarse rounded to subangular chert gravel.			
		1.00	SPT(C)	N=20 (10,6/5,5,5,5)	1.65			Orange fine sandy gravelly CLAY. Fine to coarse rounded to subangular chert gravel.	2		
		2.00	SPT(C)	N=14 (2,2/2,4,4,4)				Wetter and poorly consolidated.			
		3.00	SPT(C)	N=12 (2,2/3,3,3,3)	3.00		Orange slightly gravelly CLAY. Fine to medium chert gravel.	3			
		3.50 - 3.60	D								
4.00	SPT(C)	N=23 (3,2/4,5,7,7)	4.00		End of Borehole at 4.00m	4					
									5		
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)				Remarks	

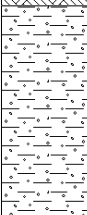
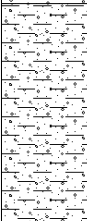
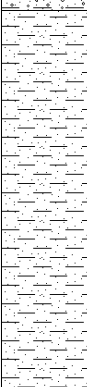
IDOM						Windowless Sample Log		Borehole No. MWS6 Sheet 1 of 1	
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS	
Location:						Level (m):		Scale 1:25	
Equipment: Premier Compact 110 Series						Dates: 15/10/2019		Logged By CEK	
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50 - 0.70	D,J	N=41 (6,7/11,10,10,10)	0.30			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1
					0.90			Orange slightly clayey medium sandy GRAVEL. Fine to coarse subangular to subrounded chert gravel.	
		1.00	SPT(C)	1.00			Orange mottled black slightly clayey fine SAND.		
		1.30	D	1.20			Orange slightly clayey medium sandy GRAVEL. Fine to coarse subangular to subrounded chert gravel.		
							Orange gravelly fine SAND. Gravel is fine to medium subangular chert. Wet.		
2.00	SPT(C)	N=12 (1,2/2,2,4,4)	2.00	End of Borehole at 2.00m		2			
									3
									4
									5

D = small disturbed sample (tub)
J = organic sample (amber glass jar)
V = volatile sample (amber glass vial)
B = bulk bag sample

SPT(C) = Standard Penetration Test (Cone)
SPT(S) = Standard Penetration Test (Split Spoon)
HSV = hand shear vane (kPa)
PP = pocket penetrometer (kg.cm2)
PID = photoionisation detector (ppm)

Remarks

IDOM						Windowless Sample Log		Borehole No. MWS7 Sheet 1 of 1			
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS			
Location:						Level (m):		Scale 1:25			
Equipment: Premier Compact 110 Series						Dates: 16/10/2019		Logged By CEK			
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.10 - 0.20	D,J	N=44 (2,4/10,11,13,10)	0.30			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1		
		1.00	SPT(C)		0.90			Orange slightly clayey medium sandy GRAVEL. Fine to coarse subangular to subrounded chert gravel.			
					1.20			Orange gravelly CLAY. Gravel is fine to coarse subangular to subrounded chert.			
					1.40			Orange slightly clayey medium sandy GRAVEL. Fine to coarse subangular to rounded chert gravel.			
										End of Borehole at 1.40m	5
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample						SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)			Remarks		

						Windowless Sample Log		Borehole No. MWS8 Sheet 1 of 1	
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS	
Location:						Level (m):		Scale 1:25	
Equipment: Premier Compact 110 Series						Dates: 16/10/2019		Logged By CEK	
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.20	D,J		0.30			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.	1
								Brown slightly gravelly CLAY. Gravel of fine to medium subangular chert.	
		1.00 1.10 - 1.20	SPT(C) D	N=7 (1,1/1,2,2,2)	1.00			Orangish brown slightly fine sandy slightly gravelly CLAY. Gravel is fine to medium subangular chert.	
		2.00	SPT(C)	N=12 (1,2/3,3,3,3)	1.75			Orangish brown slightly fine sandy CLAY. Gravel is fine to medium subangular chert.	2
		3.00	SPT(C)	N=17 (2,3/3,4,5,5)	3.00			End of Borehole at 3.00m	3
									4
									5
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)							Remarks		

IDOM						Windowless Sample Log		Borehole No. MWS9 Sheet 1 of 1			
Project Name: Reading Golf Club				Project No. 21962B		Co-ords:		Hole Type WLS			
Location:						Level (m):		Scale 1:25			
Equipment: Premier Compact 110 Series						Dates: 16/10/2019		Logged By CEK			
Well	Wtr Strk	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.00 - 0.30	D,J		0.30			TOPSOIL. Brown loamy sandy clay with occasional medium to coarse subangular chert gravel. Grass topped with rootlets throughout.		1	
		0.90 - 1.00 1.00	D SPT(C)				N=15 (2,2/3,3,4,5)		Orangish brown mottled orange CLAY.		
									Orange mottled black gravelly CLAY. Medium to coarse rounded to subangular chert gravel.		
		2.00	SPT(C)	N=17 (3,3/3,4,5,5)		Orangish brown clayey SAND.		2			
						Orange clayey medium sandy GRAVEL of fine to coarse chert.					
		3.00	SPT(C)	N=27 (4,5/5,5,7,10)		Grey CLAY.		3			
						End of Borehole at 3.50m					
											4
									5		
D = small disturbed sample (tub) J = organic sample (amber glass jar) V = volatile sample (amber glass vial) B = bulk bag sample SPT(C) = Standard Penetration Test (Cone) SPT(S) = Standard Penetration Test (Split Spoon) HSV = hand shear vane (kPa) PP = pocket penetrometer (kg.cm2) PID = photoionisation detector (ppm)							Remarks				

EMMER GREEN

British Geological Survey

SU 77/166

SU77NW

Owner READING GOLF CLUB		Licence No.		Nat. Grid Ref. SU 7146 7714	
Occupier		IGS Ref. No.		Status To be licensed.	
Ground Level 62.00 m OD		ft. OD		Aquifer D. CHALK.	
Level of Well Top 61.50 m OD		ft. OD			
Rest Water Level 36.40 m bwt		ft. bwt		Summary of Geological Section	
(Date 10.9.90) 25.60 m OD		ft. OD		Soil & pebbles	
Construction T8/CC/BC/RG				U. Chalk	
				Thickness 69.20	
				Depth 70.00	
Depth bwt	Dia.	Linings (below well top)			
		From	To	Dia.	Type
70.0m	150mm	0	15	150mm	Plain
Abstraction Rates					
gph		Type of Pump Grundfos SP27.7 Submersible			
gpd		Chem./Bact. Anal. YES NO			
		Well Driller Smith & Webb 10.9.90			

If insufficient space has been allowed, continue in 'Notes' overleaf.

APPENDIX 4

- Soil Chemistry
- Laboratory Analysis Certificates

**Keith Paramor**

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Analytical Report Number : 19-67435

Project / Site name:	Reading Golf Club	Samples received on:	21/10/2019
Your job number:	21962B	Samples instructed on:	22/10/2019
Your order number:	19-S2-FDO-LABS	Analysis completed by:	29/10/2019
Report Issue Number:	1	Report issued on:	29/10/2019
Samples Analysed:	15 soil samples		

Signed:

Rexona Rahman
Head of Customer Services
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 19-67435
 Project / Site name: Reading Golf Club
 Your Order No: 19-S2-FDO-LABS

Lab Sample Number				1338678	1338679	1338680	1338681	1338682
Sample Reference				MWS1 D1	MWS1 D2	MWS2 D1	MWS3 D1	MWS4 D1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.10-0.20	0.45-0.55	0.80-1.00	1.70-1.80	0.80-1.00
Date Sampled				16/10/2019	16/10/2019	16/10/2019	16/10/2019	16/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	7.8	7.0	9.6	16	9.5
Total mass of sample received	kg	0.001	NONE	1.2	0.90	1.4	0.61	1.1
Asbestos in Soil				Type	N/A	ISO 17025	-	-

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	6.1	6.9	7.1	7.1	7.2
Total Sulphate as SO ₄	mg/kg	50	MCERTS	-	300	180	160	-
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.0096	0.0059	0.016	-
Total Sulphur	mg/kg	50	MCERTS	-	130	61	71	-
Organic Matter	%	0.1	MCERTS	2.5	-	0.3	-	1.8

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	-	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	-	< 0.80	-	< 0.80
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	11	-	11	-	11
Boron (water soluble)	mg/kg	0.2	MCERTS	0.7	-	0.4	-	0.5
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-	< 0.2	-	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	21	-	23	-	32
Copper (aqua regia extractable)	mg/kg	1	MCERTS	9.9	-	7.4	-	12
Lead (aqua regia extractable)	mg/kg	1	MCERTS	29	-	8.9	-	17
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	-	< 0.3	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	15	-	11	-	19
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	3.4	-	< 1.0	-	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	41	-	27	-	39

Petroleum Hydrocarbons

TPH C10 - C40	mg/kg	10	MCERTS	< 10	-	< 10	-	< 10
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Analytical Report Number: 19-67435
Project / Site name: Reading Golf Club
Your Order No: 19-S2-FDO-LABS

Lab Sample Number				1338683	1338684	1338685	1338686	1338687
Sample Reference				MWS5 D1	MWS6 D1	MWS6 D2	MWS7 D1	MWS8 D1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.20	0.50-0.70	1.30	0.10-0.20	0.10-0.20
Date Sampled				16/10/2019	16/10/2019	16/10/2019	16/10/2019	16/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	20	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	20	5.4	11	8.1	15
Total mass of sample received	kg	0.001	NONE	0.70	1.4	1.1	1.1	1.1
Asbestos in Soil	Type	N/A	ISO 17025	-	-	-	-	-

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	6.4	6.9	7.2	5.2	6.1
Total Sulphate as SO ₄	mg/kg	50	MCERTS	-	210	160	-	-
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	0.013	0.012	-	-
Total Sulphur	mg/kg	50	MCERTS	-	81	58	-	-
Organic Matter	%	0.1	MCERTS	5.5	0.3	-	2.7	3.0

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	-	< 0.80	< 0.80
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	13	26	-	18	14
Boron (water soluble)	mg/kg	0.2	MCERTS	0.5	< 0.2	-	0.3	0.4
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	15	34	-	19	20
Copper (aqua regia extractable)	mg/kg	1	MCERTS	11	14	-	13	12
Lead (aqua regia extractable)	mg/kg	1	MCERTS	33	11	-	29	36
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	11	29	-	16	14
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	3.7	-	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	35	29	-	43	55

Petroleum Hydrocarbons

TPH C10 - C40	mg/kg	10	MCERTS	21	< 10	-	< 10	28
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Analytical Report Number: 19-67435
 Project / Site name: Reading Golf Club
 Your Order No: 19-S2-FDO-LABS

Lab Sample Number				1338688	1338689	1338690	1338691	1338692
Sample Reference				MWS8 D2	MWS9 D1	MWS9 D2	MWS11 D1	MWS12 D1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.10-0.20	0.10-0.30	0.90-1.00	0.10-0.30	0.10-0.30
Date Sampled				16/10/2019	16/10/2019	16/10/2019	16/10/2019	16/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	13	8.8	13	8.3	10
Total mass of sample received	kg	0.001	NONE	0.74	1.0	0.75	1.2	1.2
Asbestos in Soil	Type	N/A	ISO 17025	-	-	-	Not-detected	Not-detected

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	6.8	5.3	6.1	5.2	6.2
Total Sulphate as SO ₄	mg/kg	50	MCERTS	180	-	180	-	620
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.014	-	0.017	-	0.014
Total Sulphur	mg/kg	50	MCERTS	80	-	82	-	360
Organic Matter	%	0.1	MCERTS	-	2.3	-	2.0	3.5

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	0.30
Pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	0.31
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	-	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	< 0.80	-	< 0.80	< 0.80
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	16	-	9.0	10
Boron (water soluble)	mg/kg	0.2	MCERTS	-	0.3	-	0.3	0.5
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2	-	< 0.2	0.3
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	20	-	19	19
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	12	-	17	22
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	31	-	23	49
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3	-	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	14	-	12	11
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	< 1.0	-	1.3	1.4
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	36	-	41	60

Petroleum Hydrocarbons

TPH C10 - C40	mg/kg	10	MCERTS	-	< 10	-	< 10	< 10
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Analytical Report Number : 19-67435

Project / Site name: Reading Golf Club

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1338678	MWS1 D1	None Supplied	0.10-0.20	Brown clay and loam with vegetation and gravel
1338679	MWS1 D2	None Supplied	0.45-0.55	Brown clay and sand with gravel.
1338680	MWS2 D1	None Supplied	0.80-1.00	Brown sandy clay.
1338681	MWS3 D1	None Supplied	1.70-1.80	Beige clay.
1338682	MWS4 D1	None Supplied	0.80-1.00	Brown clay and sand.
1338683	MWS5 D1	None Supplied	0.00-0.20	Brown loam and clay with vegetation.
1338684	MWS6 D1	None Supplied	0.50-0.70	Brown sand with gravel and stones.
1338685	MWS6 D2	None Supplied	1.30	Brown sand with gravel.
1338686	MWS7 D1	None Supplied	0.10-0.20	Brown loam and clay with gravel and vegetation.
1338687	MWS8 D1	None Supplied	0.10-0.20	Brown loam and clay with vegetation.
1338688	MWS8 D2	None Supplied	1.10-0.20	Brown clay.
1338689	MWS9 D1	None Supplied	0.10-0.30	Brown clay and loam with vegetation and gravel
1338690	MWS9 D2	None Supplied	0.90-1.00	Brown clay.
1338691	MWS11 D1	None Supplied	0.10-0.30	Brown loam and clay with vegetation and gravel
1338692	MWS12 D1	None Supplied	0.10-0.30	Brown clay and loam with vegetation and gravel

Analytical Report Number : 19-67435

Project / Site name: Reading Golf Club

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	MCERTS
TPH Banding in Soil by FID	Determination of hexane extractable hydrocarbons in soil by GC-FID.	In-house method, TPH with carbon banding and silica gel split/cleanup.	L076-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

APPENDIX 5 ▪ Geotechnical Laboratory Certificates



TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS



Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

Client: Merebrook
Client Address: First Floor, 1 Leonard Place,
Westerham Road, Keston,
BR2 6HQ
Contact: Keith Paramor
Site Name: Reading Golf Club
Site Address: Not Given

Client Reference: 21962-B
Job Number: 19-67504
Date Sampled: 15/10/2019
Date Received: 22/10/2019
Date Tested: 28/10/2019
Sampled By: CEK

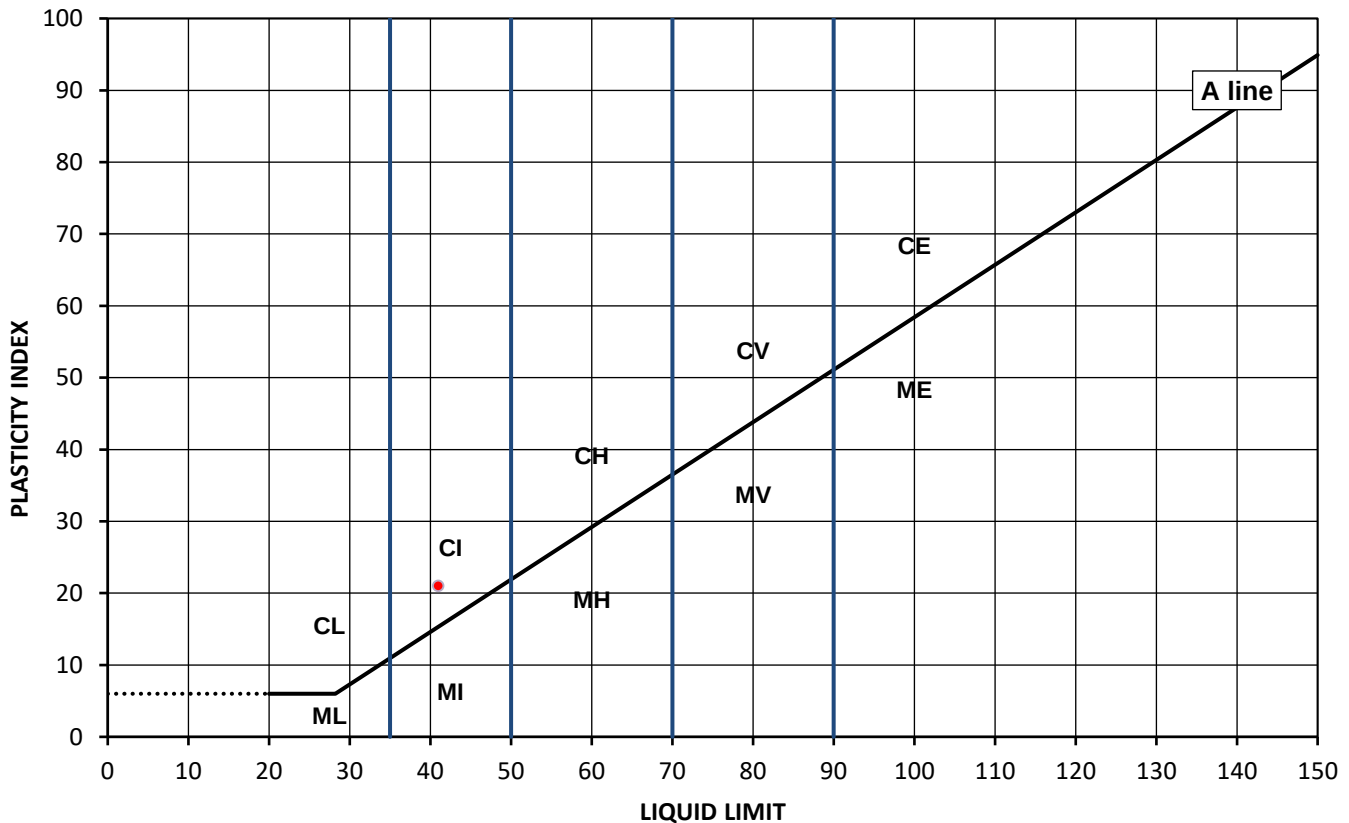
Test Results:

Laboratory Reference: 1339036
Hole No.: BH1
Sample Reference: D2
Soil Description: Brown slightly gravelly sandy CLAY

Depth Top [m]: 2.00
Depth Base [m]: Not Given
Sample Type: D

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
12	41	20	21	73



Legend, based on BS 5930:2015 Code of practice for site investigations

C	Clay	Plasticity	Liquid Limit
M	Silt	L	Low below 35
		I	Medium 35 to 50
		H	High 50 to 70
		V	Very high 70 to 90
		E	Extremely high exceeding 90
	Organic	O	append to classification for organic material (eg CHO)

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 05/11/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 236.5

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This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.
The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland.*

Any assessment of compliance with specifications based the analytical results in a report take in to account no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.



TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS



Environmental Science

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

Client: Merebrook
Client Address: First Floor, 1 Leonard Place,
Westerham Road, Keston,
BR2 6HQ
Contact: Keith Paramor
Site Name: Reading Golf Club
Site Address: Not Given

Client Reference: 21962-B
Job Number: 19-67504
Date Sampled: 16/10/2019
Date Received: 22/10/2019
Date Tested: 28/10/2019
Sampled By: CEK

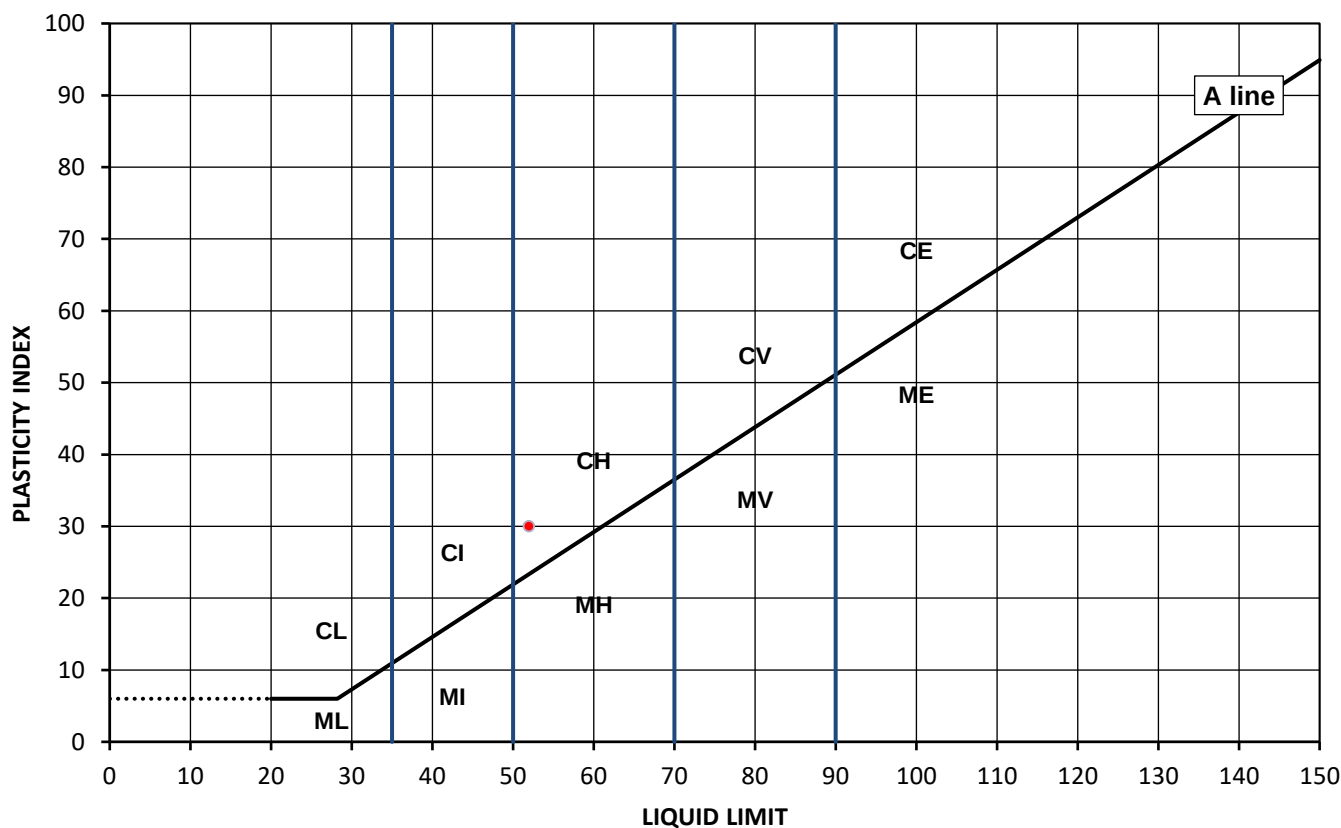
Test Results:

Laboratory Reference: 1339038
Hole No.: BH2
Sample Reference: D2
Soil Description: Brown slightly gravelly slightly sandy CLAY

Depth Top [m]: 2.00
Depth Base [m]: Not Given
Sample Type: D

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
19	52	22	30	97



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity	Liquid Limit
C	Clay	L Low	below 35
M	Silt	I Medium	35 to 50
		H High	50 to 70
		V Very high	70 to 90
		E Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 05/11/2019

Signed: Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd GF 236.5

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The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland.*



TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS



Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

Client: Merebrook
Client Address: First Floor, 1 Leonard Place,
Westerham Road, Keston,
BR2 6HQ
Contact: Keith Paramor
Site Name: Reading Golf Club
Site Address: Not Given

Client Reference: 21962-B
Job Number: 19-67504
Date Sampled: 15/10/2019
Date Received: 22/10/2019
Date Tested: 28/10/2019
Sampled By: CEK

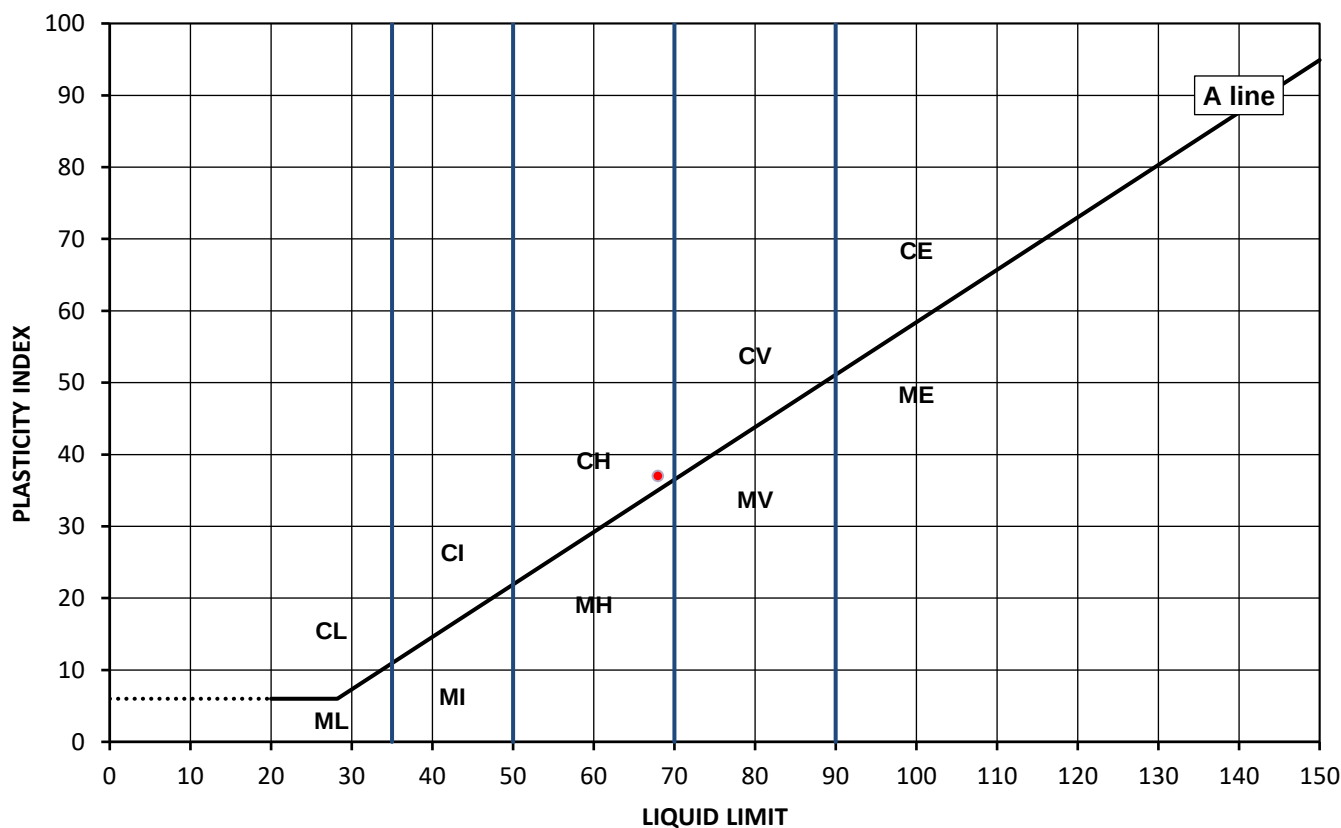
Test Results:

Laboratory Reference: 1339039
Hole No.: BH3
Sample Reference: D1
Soil Description: Dark brown gravelly CLAY

Depth Top [m]: 1.00
Depth Base [m]: Not Given
Sample Type: D

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425um BS Test Sieve
11	68	31	37	55



Legend, based on BS 5930:2015 Code of practice for site investigations

C	Clay	Plasticity	Liquid Limit
M	Silt	L	Low
		I	Medium
		H	High
		V	Very high
		E	Extremely high
	Organic	O	append to classification for organic material (eg CHO)

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 05/11/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 236.5

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The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland.*



SUMMARY REPORT

Summary of Classification Test Results

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS



Tested in Accordance with:

MC by BS 1377-2: 1990: Clause 3.2; WC by BS EN 17892-1: 2014; Atterberg
by BS 1377-2: 1990: Clause 4.3, Clause 4.4 and 5; PD by BS 1377-2: 1990:
Clause 8.2

Client Reference: 21962-B

Job Number: 19-67504

Date Sampled: 15/10 - 16/10/2019

Date Received: 22/10/2019

Date Tested: 28/10/2019

Sampled By: CEK

Client: Merebrook
Client Address: First Floor, 1 Leonard Place,
Westerham Road, Keston,
BR2 6HQ
Contact: Keith Paramor
Site Name: Reading Golf Club
Site Address: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	MC	WC	Atterberg				Density			Total Porosity#		
		Reference	Depth Top m	Depth Base m	Type					% Passing 425um	LL	PL	PI	bulk Mg/m3	dry Mg/m3	PD Mg/m3			
1339036	BH1	D2	2.00	Not Given	D	Brown slightly gravelly sandy CLAY	Atterberg 4 Point	12		73	41	20	21						
1339038	BH2	D2	2.00	Not Given	D	Brown slightly gravelly slightly sandy CLAY	Atterberg 4 Point	19		97	52	22	30						
1339039	BH3	D1	1.00	Not Given	D	Dark brown gravelly CLAY	Atterberg 4 Point	11		55	68	31	37						

Note: # Non accredited; NP - Non plastic

Comments:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 05/11/2019

Signed: Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd GF 238.7

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The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."



TEST CERTIFICATE

Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS



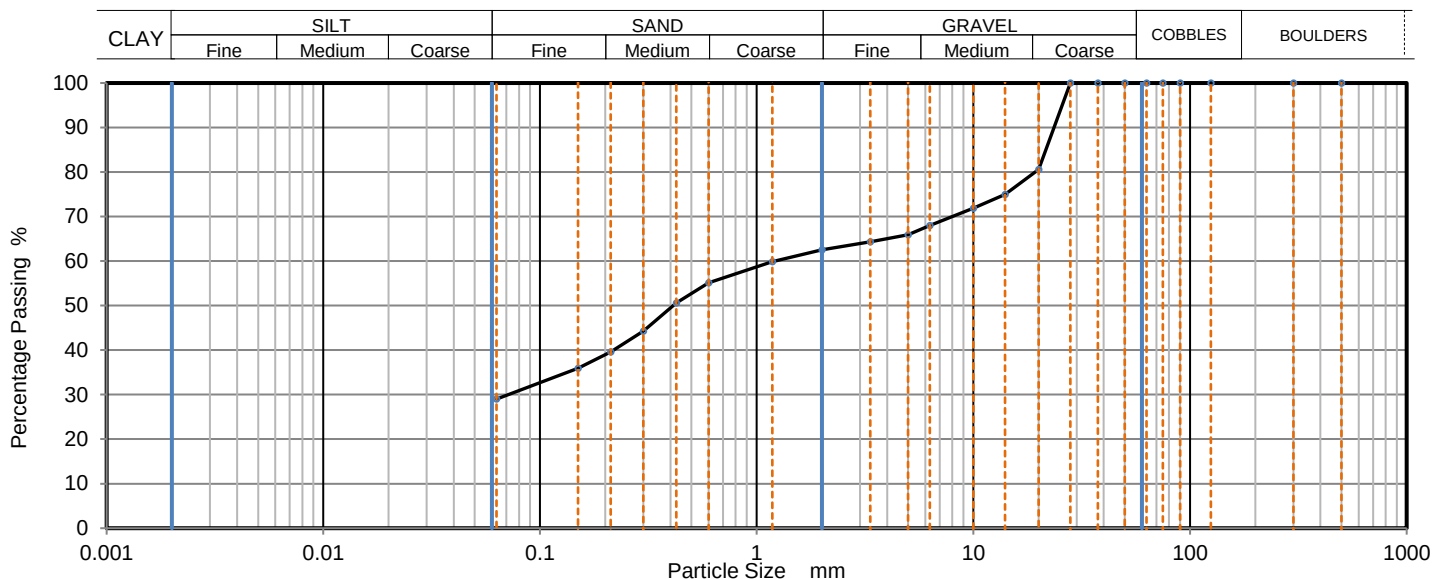
Client: Merebrook
Client Address: First Floor, 1 Leonard Place,
Westerham Road, Keston,
BR2 6HQ
Contact: Keith Paramor
Site Name: Reading Golf Club
Site Address: Not Given

Client Reference: 21962-B
Job Number: 19-67504
Date Sampled: 15/10/2019
Date Received: 22/10/2019
Date Tested: 28/10/2019
Sampled By: CEK

Test Results:

Laboratory Reference: 1339035
Hole No.: BH1
Sample Reference: D1
Sample Description: Brown very clayey very sandy GRAVEL

Depth Top [m]: 1.00
Depth Base [m]: Not Given
Sample Type: D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
500	100		
300	100		
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	81		
14	75		
10	72		
6.3	68		
5	66		
3.35	64		
2	63		
1.18	60		
0.6	55		
0.425	51		
0.3	44		
0.212	40		
0.15	36		
0.063	30		

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	37.50
Sand	32.70
Fines <0.063mm	29.80

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Note: Tested in Accordance with BS1377:Part 2:1990, clause 9.2

Remarks: The material submitted - fails to meet the minimum mass requirements as stated in BS1377 Part 2 Table 3

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 05/11/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 100.13



TEST CERTIFICATE

Particle Size Distribution

Tested in Accordance with: BS 1377-2: 1990

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS



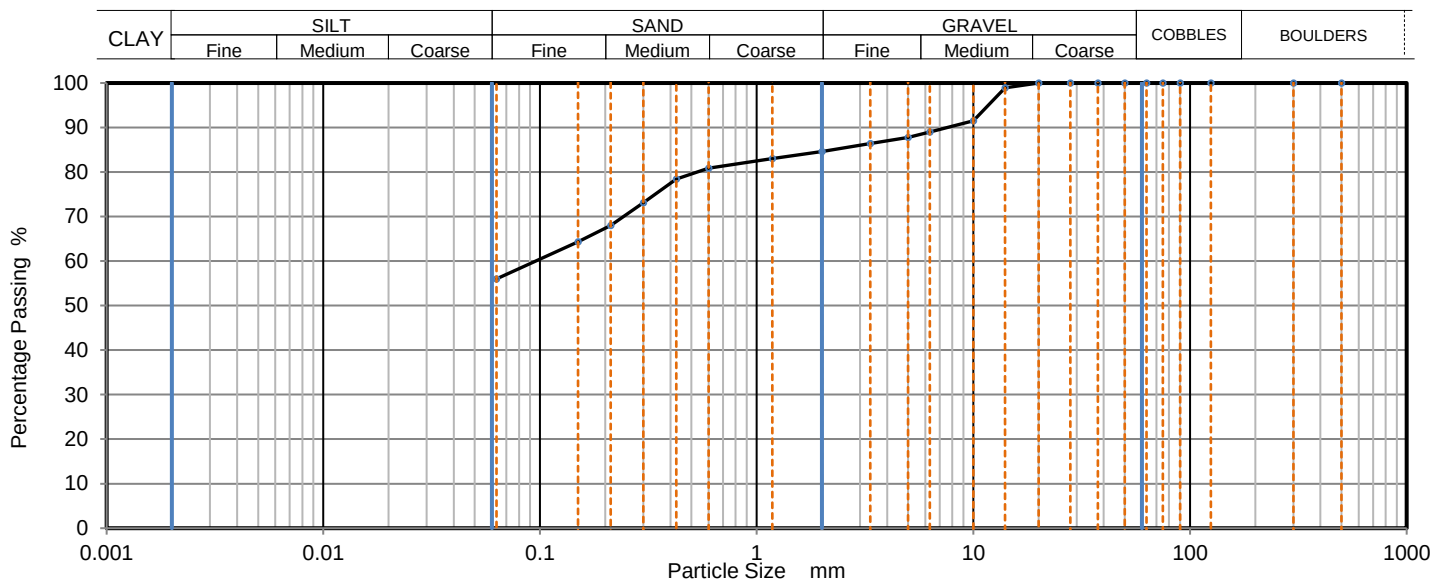
Client: Merebrook
Client Address: First Floor, 1 Leonard Place,
Westerham Road, Keston,
BR2 6HQ
Contact: Keith Paramor
Site Name: Reading Golf Club
Site Address: Not Given

Client Reference: 21962-B
Job Number: 19-67504
Date Sampled: 16/10/2019
Date Received: 22/10/2019
Date Tested: 28/10/2019
Sampled By: CEK

Test Results:

Laboratory Reference: 1339037
Hole No.: BH2
Sample Reference: D1
Sample Description: Brown gravelly sandy CLAY

Depth Top [m]: 1.00
Depth Base [m]: Not Given
Sample Type: D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
500	100		
300	100		
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	99		
10	92		
6.3	89		
5	88		
3.35	86		
2	85		
1.18	83		
0.6	81		
0.425	78		
0.3	73		
0.212	68		
0.15	64		
0.063	57		

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	15.40
Sand	27.90
Fines <0.063mm	56.80

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Note: Tested in Accordance with BS1377:Part 2:1990, clause 9.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager
Date Reported: 05/11/2019

Signed: Darren Berrill
Geotechnical General Manager
for and on behalf of i2 Analytical Ltd GF 100.13

APPENDIX 6

- Field Monitoring Records
- Groundwater Level Data
- Hazardous Soil Gas Data

GAS MONITORING RECORD ROUND 1

Location Reference	Time	Flow and Pressure Measurements				Gas Measurements						VOC Measurements		Dip Measurements		Comments
		Flow		Atmospheric Pressure	Differential Pressure	Methane	Methane LEL	Carbon Dioxide	Oxygen	Carbon Monoxide	Hydrogen Sulphide	Hexane	PID	Depth to Water	Depth to Base	
		max	steady													
		l hr ⁻¹		mb	Pa	%	%	%	%	ppm	ppm	%	ppm	m	m	
MWS1	-	-	-	-	-	-	-	-	-	-	nr	-	nr	-	-	Not sampled as hole covered.
MWS3	12:40	0	0	994	0	0	0	1.4	17.3	-10	0	0.007	nr	DRY	4.25	-
MWS5	12:30	0	0	995	0	0	0	4.1	15.3	0	0	0.007	nr	DRY	4.70	-
MWS9	12:20	15	0	995	0	0	0	2.3	16.3	-10	0	0.008	nr	1.15	2.70	-
MWS12	12:10	16	3	995	9	0	0	1.8	18.1	-1	0	0.009	nr	0.95	1.80	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weather:		Overcast				nr = not recorded			Gas Analyser		PID		Site:		Reading Golf Club	
						Model:			GFM435		-		Project Number:		21962B	
						Serial Number:			11839		-		Monitored By:		Chloe Kirkpatrick	
						Date of Last Calibration:			21/06/2019		-		Date:		06/11/2019	

APPENDIX 7 ▪ Gas Risk Assessment

NHBC TRAFFIC LIGHT GAS CHARACTERISTIC SITUATION

SITE: Reading Golf Club

JOB NUMBER: 21962B

13/11/2019

Carbon Dioxide				Methane			
Maximum Gas Concentration	4.10	%		Maximum Gas Concentration	0.10	%	
Maximum Measured Steady Flow	3.00	L hr ⁻¹		Maximum Measured Peak Flow	16.00	L hr ⁻¹	
Gas Screening Value	0.12	L hr ⁻¹		Gas Screening Value	0.02	L hr ⁻¹	
Characteristic Situation	Green			Characteristic Situation	Green		
if measured values are zero then resolution limit of instrument is used for calculation of GSV							
worst case carbon dioxide or methane characteristic situation value defines overall characteristic situation for the site							

NHBC Classification

Protection Measures

Characteristic Situation	Carbon Dioxide		Methane		Identified Gas Regime	Protection Measures Required
	Typical Maximum Concentration (%v/v)	Gas Screening Value (L hr ⁻¹)	Typical Maximum Concentration (%v/v)	Gas Screening Value (L hr ⁻¹)		
Green					negligible	Ground gas protection measures are not required
	5	0.78	1	0.16		
Amber 1					low to intermediate	Low-level ground gas protection measures are required, using a membrane and ventilated sub-floor void that creates a permeability contrast to limit the ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours
	10	1.56	5	0.63		
Amber 2					intermediate to high	High-level ground gas protection measures are required, creating a permeability contrast to prevent ingress of gas into buildings. Gas protection measures are to be installed as prescribed in BRE 414. Membranes used should always be fitted by a specialist contractor and should be fully certified (see Appendix E). As with Amber 1, ventilation of the sub-floor void should be designed to provide a minimum of one complete volume change per 24 hours.
	30	3.10	20	1.56		
Red					high	Standard residential housing is not normally acceptable without further Ground Gas Risk Assessment and/or possible remedial mitigation measures to reduce/remove the source of the ground gases. In certain circumstances, active protection methods could be applied, but only when there is a legal agreement assuring the management and maintenance of the system for the life of the property.

IDOM

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Registered in England No. 02740216 Registered office: as above

offices Birmingham London Kent Derbyshire Cardiff Manchester Stirling

Appendix G – Ground Investigation Report