Herefordshire Council

Geotechnical Appraisal Report

Wyebridge Sports Academy, Hereford

Report No. 2911

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Job No. 00551378

Geotechnical Appraisal Report
Wyebridge Sports Academy
Hereford

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1 Introduction

1.1 Owen Williams' geotechnical team has been commissioned by Richard East of Herefordshire Council to undertake a geotechnical appraisal of the land currently occupied by Wyebridge Sports Academy, which is located on the southern outskirts of Hereford. The proposals for the site involve constructing a new sports academy which will replace the existing high school buildings.

1.2 At the time of undertaking this report the proposed layout was not known although we were informed by the Client that the new buildings were likely to be located in the northern part of the site. A series of exploratory holes were subsequently undertaken, concentrating on the northern part of the site, but also covering the area immediately west and south of the existing school buildings.

1.3 This appraisal report describes the historical background of the site and the ground conditions encountered during the site investigation undertaken in August 2007. The report also gives outline / preliminary geotechnical recommendations for the proposed scheme.

2 Site description

2.1 As shown on the appended plan, Drg. No. 2911_01, the proposed site is centred on National Grid Reference 350120,238040. The site lies approximately 2 km south-southwest of Hereford city centre and currently has the address: Wyebridge Sports College, Stanberrow Road, Hereford, HR2 7NG.

2.2 The ground at the site has a general southerly fall, although it has been terraced by cut and fill operations to form a series of level playing fields and tennis court areas. An L-shaped bund, which is approximately 3.4 m high and has a sideslope of around 1v: 2.75h (20^o), is also present to the north and west of the tennis courts. Based on spot heights shown on the Ordnance Survey Landline plans of the area, the northern part of the site has an elevation of around 70 m AOD and the playing fields at the southern end of the site are at around 60 m AOD.

2.3 The site is roughly triangular in shape, measuring approximately 400 m, 300 m and 300 m along its western, northeastern and southeastern boundaries, respectively. The site covers an area of approximately 61,450 m^2 and is bordered on the north and northeastern sides by semi-detached properties along Frome Avenue and Stanberrow Road. The southeastern and southern boundaries are shared with Beaufort Avenue, Falstaff Road and properties in Glendower Close. A cycle track runs along the southwestern boundary of the site and links Beaufort Avenue with land on the western side the adjacent Great Western Way, over a small overbridge. The Great Western Way, a disused railway now used as a designated cycle route and bridleway between the school and the city centre, runs along the western boundary of the site.

2.4 The site is currently occupied by school buildings and amenities of Wyebridge Sports College. The main school buildings occupy the northern half of the site and include a main building with administration facilities and a science block extension, a kitchen building, sports hall, geography & history block, an arts block and parking areas. The area immediately to the south of the buildings is occupied by parking areas, tennis courts and play areas. The remainder of the site comprises sports fields and playing fields. An electrical sub-station lies in the northern part of the site adjacent to the access off Stanberrow Road.

2.5 Service plans indicating locations of statutory undertaker's plant were provided by Herefordshire Council and can be summarized as follows:

- British Telecom (BT) records indicate underground plant in the car park and macadam areas between the main school entrance, main school buildings, arts building and the geography & history block.

- The records of Welsh Water indicate storm water drainage in the highway along Frome Avenue and Stanberrow Road, along the verge between Beaufort Avenue, Falstaff Road and the southern boundary of the school, and along the cycle track that runs along the school's southwest boundary. Further plant is indicated at the main entrance to the school. No storm water drainage is indicated in the area around the ground investigation.

- Welsh Water's records also show foul water drainage along Frome Avenue, Stanberrow Road, Beaufort Avenue and Falstaff Road. A foul sewer is also indicated crossing the southwestern corner of the site, from Great Western Way to Beaufort Avenue.

- Records belonging to *e*.on (electricity) indicate electrical services along the south side of the residential roads adjacent to the southern boundary of the site and also in the roads to the east. Underground services enter the site beneath the main school entrance and link with the main school buildings and the history and geography block. No services are shown in the area of the ground investigation.

- Electrical contractor's plans show 100 mm diameter underground mains cable linking the kitchen, boiler room and geography & history block buildings in the north-west corner of the school. No services are shown in the vicinity of the ground investigation.

3 Site history

3.1 A series of historical Ordnance Survey maps dating from 1885 to the present day were acquired (Groundsure, 2007) and are summarized below;

3.2 The earliest maps of the area surrounding the site are dated 1885 to 1886 and are at 1:10,560 scale. The site itself lies on the 1886 map, then being shown as a field. The current school boundary is coincident with the boundaries of the field. The site is bordered by the Hereford, Abergavenny & Newport Branch railway to the south (still existing) and the Great Western Railway in a cutting immediately to the west (now dismantled). The junction of the two railways is shown about 1 km south east of the site and is labeled 'Redhill Junction'. A footpath is indicated crossing the Great Western Railway at the southern edge of the site, at a location now occupied by the cycle way. A small water body, a pond no greater than 10 m by 5 m, is indicated at the southern end of the field.

There are very few developments in the area, which mainly consists of agricultural fields, divided by hedges, watercourses and drainage ditches. The nearest buildings comprise Newton Farm and Newton House and these are shown approximately 1.5 km to the northeast. The nearest settlement is Blackmarstone, which lies 4 to 5 km to the north-northeast. A road, now the A49 Ross Road, crosses the railway line at Red Hill. The road that is now the A465 passes under the Great Western Railway, in a cutting, approximately 2 km to the north of the site.

3.3 The 1:2500 scale map surveyed in 1888 shows little change to that above. In addition to the small pond at the southern end of the site, a second pond is shown within the site boundary at the eastern end of the site, and a third approximately 60 m east of this. These ponds are joined by the watercourse running along the site boundary. This watercourse has small trees shown on its banks throughout its length.

3.4 The next map, a 1903 revision of the 1886 map, shows no significant development or revisions in the vicinity of current school site. No vegetation is shown along the watercourse running along the southern boundary of the site.

3.5 Larger scale mapping dated 1904, surveyed at 1:2500, confirms the presence of the railway lines and footpath described above and again omits the trees adjacent to the watercourse.

3.6 The 1928 1:10,560 map indicates some minor changes in the area around the site. These revisions include an allotment located approximately 1.5 km northeast of the site, two new farm buildings at Newton Farm, and two new buildings at Redhill Junction, possibly connected with the nearby Grafton House.

3.7 The 1938 1:10,560 map indicates several new minor roads and adjacent buildings in Blackmarstone. These include Wallis Avenue, Rogers Avenue and Charles Witts Avenue to the west of the Great Western Railway and Hinton Crescent and Court Crescent to the southeast of the built-up area. A large building is shown just east of what is now the A49 in Blackmarstone. There are no notable changes to the site itself.

3.8 The 1945 map indicates significant changes to the development around Blackmarstone. Several minor roads are indicated branching off to the east of Ross Road. These roads include Web Tree Avenue, Garrick Avenue, and Red Hill Avenue. Several new buildings are shown on the northern side of the current A465, just over 2 km north of the site.

The pond shown previously is not indicated on this map. However, the watercourse is shown running in a northeasterly direction from the pond's previous location, along the southeastern boundary.

The 1945 maps show several new minor roads south and southeast of Blackmarstone. These branch off Walnut Tree Lane, Holme Lacey Road and also the A49 Ross Road. The building east of the A49 shown on the 1938 map is identified as a school. Developments also include a series of long rectangular buildings approximately 1.5 km northeast of the site, which are labeled 'Redhill Hostel'.

3.9 Maps showing 1965 revisions to the 1945 maps indicate further developments around and on the site of Wyebridge School. Military barracks are shown east of the A49 and much of the current road layout is in place. Roads are shown along the alignments of the current Stanberrow Road, Beaufort Avenue, and Falstaff Road, but these are un-named. Further minor roads are shown west of the Great Western Railway. A single building is shown on the site but this is unlabelled and could be under construction. A school building is shown about 1 km northeast of the site and at the location of the current Marlbrook County Primary School. The watercourse, previously shown along the southeast border of the site, is not shown on this map and is likely to have been diverted under the new road, i.e. Marlbrook Road.

3.10 Large scale maps (1:2500) produced between 1966 and 1967 show the current road names. The school shown on the 1945 map is labelled as Redhill County Secondary School. The site of Wyebridge High School is shown in greater detail and comprises two school buildings which, in plan, resemble the current buildings. These are labeled Redhill County Primary School (now the arts block) and Grafton County Secondary School (occupying the current main school buildings and reception). The current tennis court, car park and associated access roads, pavements and earthworks are also shown.

The Great Western Railway is marked as disused on the 1967 map, although both northbound and southbound tracks are shown. Revisions to the above 1966 and 1967 maps, issued in the same years, show the tracks to have been lifted.

3.11 The most recent maps consulted, surveyed in 1982 and revised in 1983, show the site and surrounding area much as it is today at present. The two schools are labeled as Haywood Upper and Lower School, west and east of Stanberrow Road respectively. Nearby suburbs of Hereford are labeled as Newton Farm, to the west, and Redhill, to the east.

4 Fieldwork

4.1 A topographic survey of the site was carried out by Owen Williams' Survey Division between July and August 2007 but was not available until after the ground investigation.

4.2 The exploratory holes were excavated in positions agreed with the Client. The ground investigation was undertaken on the 2nd August 2007. As shown on the appended Fieldwork Location Plan, Drg. No. 2911_01, the ground investigation comprised:

- 8 No. trial pits (TP01 to TP11, excluding TP05, TP06 and TP07) excavated to depths of up to 3.7 m. The pits were excavated using an extending arm JCB. TP07 was not excavated due to the high concentration of buried services detected.

- 2 No. hand auger holes (HA05 and HA06) were excavated to depths of 1.4 m and 1.5 m, respectively, in lieu of TP05 and TP06. These were located to the west and north of the tennis court, southwest of the main school buildings, where machine access was not possible. The hand auger holes were drilled using a 70 mm diameter post auger.

Fieldwork logs are included in the appendices.

4.3 Disturbed bag samples were taken at appropriate depths in the trial pits and hand auger holes, to allow subsequent laboratory testing. The information derived from the fieldwork is presented in the appended fieldwork logs. Soil and rock descriptions are in accordance with the latest British Standards: BS EN ISO 14688-4: 2002, BS EN ISO 14688-2: 2004 and BS EN ISO 14689-1: 2003, which have superseded BS 5930: 1999.

4.4 Where possible, a hand shear vane was used in the more cohesive strata to measure the undrained shear strength of the materials encountered. A Farnell cone penetrometer (Mexe-probe) was also used, where appropriate, to assess the in-situ CBR value.

5 Laboratory testing

5.1 A small programme of geotechnical laboratory testing was carried out, consisting of natural moisture content and Atterberg limit determinations (liquid and plastic limit) to aid classification of the soil, and the determination of sulphate and pH levels. The test results are appended.

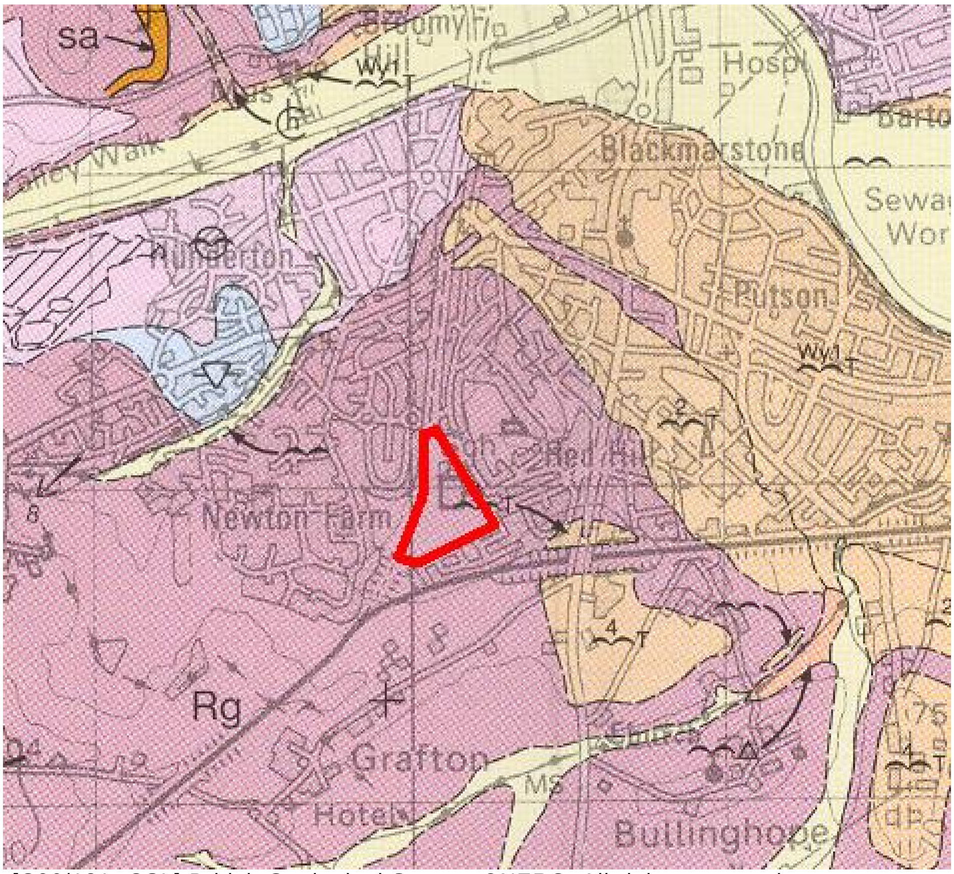
5.2 A programme of contamination testing was also undertaken. This consisted of testing for metals, selenium, pH, organic content, total petroleum hydrocarbons (TPH), asbestos, speciated poly-aromatic hydrocarbons (PAH), polychlorinated biphenols (PCBs), and total cyanide. PCBs and cyanide were undertaken as an initial screen at the locations closest to the railway.

6 Ground conditions

6.1 Published geology

6.1.1 According to the records of the British Geological Survey (BGS, 2000), and as shown in Figure 1 below, the site overlies the Raglan Mudstone Formation. Superficial deposits are shown in the areas surrounding the site and include undifferentiated glacial deposits, approximately 500 m to the northwest, and terrace deposits of the River Wye 400 m to the southeast and 500 m to the northwest. A band of alluvium is shown following the current course of the River Wye, approximately 1 km to the north of the site. Glacio-fluvial sands and gravels are indicated as occupying the area between the glacial deposits and the alluvium adjacent to the Wye.

Figure 1- Extract of geological plan (BGS, 2000). Raglan Mudstone is shown in dark pink, glacial deposits in blue and light pink, river terrace deposits in orange and alluvium in yellow. The site is highlighted in red.



6.1.2 The Raglan Mudstone Formation is late Silurian in age (Downtonian) and forms part of the Lower Old Red Sandstone Group. In the area between Hereford and Ross-on-Wye, the formation is estimated to be between 385 m and 700 m thick (BGS, 2000). It generally thickens to the west and typically comprises repetitive fining-up sequences of red brown mudstones, siltstones with some subordinate sandstones and calcretes (Barclay & Smith, 2002).

6.1.3 The undifferentiated glacial deposits include moraines comprising sandy tills, gravels and clays (BGS, 2000). These deposits were laid down during the most recent stage of glaciation during the Dimlington Interstadial of the Devensian stage. Brandon (1989) refers to these deposits as the Newer Till, which he describes as a reddish brown , clayey to sandy silt with unsorted cobble to boulder-sized clasts. Clasts are likely to include greywackes, vein quartz and volcanic rocks with a Welsh provenance as well as more locally-derived sandstones, siltstones and calcretes (Barclay & Smith, 2002).

6.1.4 The glacio-fluvial sand and gravels were deposited during the Windermere Interstadial of the Devensian glaciation. These are likely to comprise glacial outwash gravels underlying a thin layer of silt. Barclay & Smith (2002) estimate this deposit to have a thickness of between 7.0 m and 10.5 m.

6.1.5 The terrace deposits of the River Wye are subdivided into the First and Second Terrace Deposits, both of which are Flandrian. Both comprise variable thicknesses of silt, silty clay and sandy clay overlying gravels.

6.1.6 All strata in the area is indicated to be lying horizontally and there are no faults or other structures of significance shown in the vicinity.

6.2 Hydrogeology

6.2.1 The Environment Agency's groundwater vulnerability maps (Environment Agency, 1996 & National Rivers Authority, 1995) show the Raglan Mudstone Formation and Lower Old Red Sandstone to be a variably permeable minor aquifer. Although not usually used for abstraction minor aquifers can be important for local supplies and also in supplying base flow to rivers, in this case the nearby River Wye. The soils overlying the bedrock are shown to have a high leaching potential.

6.2.2 According to the Environment Agency records (2006) the site does not lie within a Source Protection Zone (SPZ). The nearest abstraction point is located at Grid Reference 348630,241190, approximately 3 km northwest of the site.

6.2.3 The presence of the various surface water features suggests ground water level may be high.

6.2.4 Environment Agency records (2007) indicate the site is not at risk from flooding. The nearest flood risk areas include those adjacent to the River Wye, approximately 1 km north of the site, and that adjacent to Withy Brook, 800 m to the southeast.

6.3 Strata encountered

6.3.1 The findings of the exploratory holes generally agree with the records of the BGS. Each hole encountered between 0.1 and 0.2 m of topsoil overlying either made ground with reworked Raglan Mudstone or directly overlying the clays and mudstones of the Raglan Mudstone Formation.

6.3.2 The topsoil was found to comprise turf over firm to stiff medium to dark brown clays and silty clays with small rootlets. In TP10 larger roots were encountered to approximately 0.2 m depth, typically with a root diameter up to 10 mm. These roots were orientated lengthways within the trial pit, running in a west to east direction and appeared to originate from an area of small trees and bushes at the shoulder of the railway embankment, a few metres to the west of the pit.

6.3.3 Made ground was encountered in HA06, TP08 and TP11 to depths of 0.7 m, 0.5 m and 0.4 m, respectively. HA06 was located adjacent to the tennis courts and TP08 and TP11 were positioned adjacent to the new parking area north of the main school buildings and close to the shoulder of a shallow bank at the northeast corner of the site respectively (as shown on appended Dwg. No. 2911_01). The made ground in each hole comprised slightly different material. In HA06 the made ground comprised loose fine limestone aggregate and is considered to be associated with the drainage of the adjacent tennis court. The made ground encountered in TP08 comprised firm medium brown slightly silty clay with rootlets, sections of discarded wire and small coal fragments. The material in TP11 was found to be medium strength (50 to 68 kPa, firm) light reddish brown slightly fissured clay. The made ground also contained occasional sub-rounded coarse gravel and cobbles of quartzite and limestone as well as angular fragments of brick and wire. The distinct colouration and the occurrence of the quartzite and limestone clasts encountered in this pit are typical of the Raglan Mudstone Formation. The material appears to have been excavated and reworked at some point in its recent history.

6.3.4 Raglan Mudstone was encountered immediately beneath the topsoil in pits TP01 to TP04, HA05 and in TP09 to TP10. It was also encountered beneath the made ground in holes HA06, TP08 and TP11. Two distinct lithologies were encountered. Medium to high strength (61 to 90 kPa, firm to stiff) dark reddish brown clay and silty or sandy clays were encountered in most exploratory holes, excluding TP09. These were encountered to variable depths between 0.5 m (TP08) and 2.2 m (TP11) below ground level. Beneath the clays the Raglan Mudstone comprised probably weak to medium strong reddish brown friable and fissured mudstone at depths ranging from 0.2 m to 2.5 m. This was also found to occasionally contain layers of thickly laminated micaceous siltstone. The material excavated from the exploratory holes tended to be retrieved as clayey gravel and is interpreted to be a mudstone with interbedded clays and occasional siltstones.

6.4 Groundwater

6.4.1 Groundwater was encountered in a number of the exploratory holes as shown in the table below. These holes were located on the lower part of the site, mainly on the playing field to the south of the existing school buildings.

Exploratory hole	Depth groundwater encountered	Comments
TP01	3.2 m	Slight seepage
TP03	3.4 m	Slight seepage
TP04	0.6 m	Slight seepage
TP04	2.3 m	Heavy seepage
HA06	0.5 m to 0.6 m	Damp

It is likely that the groundwater table will be higher during the winter months on this essentially clayey site.

6.5 Land contamination

6.5.1 Contamination levels in the soil were generally very low with the organic determinands not exceeding their respective limits of detection (LOD). Metals and selenium have been reported above their LOD in the lab results, and the level of nickel exceeded background levels in some cases. The pH was approximately neutral at an average of pH 7.8 and no asbestos was encountered.

6.5.2 Levels of leachable contaminants were also low with levels of organic determinands and selenium not exceeding their LOD. The only metals reported above their LOD were lead, zinc and copper. The average pH of the eluate was reported as 5.8.

7 Land Contamination Risk Assessment

7.1 Human health risk assessment

The contamination test results were analysed using the statistical methods outlined in CLR 7 (Environment Agency and DEFRA, 2002) to identify the mean value and maximum value, and to provide an indication of the population mean and the presence of statistical outliers.

As the site proposals have yet to be finalized, two possible land uses were considered: *residential without plant uptake* as a conservative screen of risk from school buildings being constructed across the site; and *playing fields* (as defined by the ATRISK^{soil} database) where land would remain undeveloped.

The results of the mean value test were compared with published soil guideline values (SGV) produced by DEFRA and the EA for human health risk assessment (Environment Agency, 2002-2005) where available for the *residential without plant uptake* land use.

Where published SGVs were not available and where the *playing fields* land use was assessed, the ATRISK^{soil} database of soil screening values (SSV, Atkins, 2007) was used. These values represent generic assessment criteria (GAC) developed under the UK approach to risk assessment. They are fully compliant with the parameters specified in the EA and DEFRA's CLR series of guidance documents and the CLEA briefing notes (Environment Agency and DEFRA, 2005). The risk to human health from asbestos fibres was assessed using the threshold provided in the ICRCL guidance note 64/85: Asbestos on Contaminated Sites (Interdepartmental Committee on the Redevelopment of Contaminated Land, 1990).

The results of the human health risk assessment indicate an exceedance for nickel when the *residential without plant uptake* land use was considered. Nickel concentrations were found to marginally exceed the residential land use SGV at levels of up to 66 mg/kg compared to the SGV of 50 mg/kg. This was shown to be indicative of the underlying population and not a statistical outlier or hotspot. However, several exploratory hole locations were found not to be subject to nickel contamination. It is recommended that further detailed contaminated land investigation and risk assessment is carried out, giving due consideration to the elevated levels of nickel, following confirmation of site proposals and prior to any construction works.

No other determinand exceeded their respective assessment criterion in the *residential without plant uptake* or the *playing fields* land use.

7.2 Controlled waters risk assessment

In order to assess the risk to the underlying minor aquifer, soil eluate (leachability) values were compared with drinking water standards (Office for Public Sector Information, 1989/1990) and environmental quality standards (Environment Agency, 2007) in accordance with the ground and surface water risk assessment set out in Level 1 of the EA's Remedial Targets Methodology (formerly P20, Environment Agency, 2007). This was to provide an initial assessment of the risk of leaching of contaminants to groundwater and migration to surface waters.

The Level 1 risk assessment did not indicate a risk to the underlying aquifer from any of the determinands.

8 Discussion and preliminary recommendations

8.1 Discussion

The following sections present preliminary recommendations which should be confirmed by further investigation once the detailed layout and proposals for the site have been finalized.

The further investigation should comprise a series of trial pits excavated adjacent to the proposed buildings, access roads etc so that the ground conditions and recommendations given below can be confirmed. Further sampling for both geotechnical and contamination testing are also recommended.

8.2 Preliminary recommendations

8.2.1 Excavations

From the records of the fieldwork we anticipate no major problems with excavations at the site. Excavations at this site should generally be manageable with a JCB back-hoe excavator or similar. However, some slow dig was experienced in TP01, TP08 and TP11 in the more competent mudstones and siltstones. Confined or narrow excavations for manholes, drain runs, or foundations, etc, may prove difficult in the mudstones/siltstones if the rock strength is high and the discontinuity spacing large. Hand excavation using breakers, or a pneumatic pecker, may be required. Some overbreak may be experienced.

No pre-existing shear surfaces were observed during the investigation. Generally the pits sides remained stable during excavation, although slight overbreak was experienced in TP03 and TP04 due to the closely fissured nature of the strata encountered. Shoring should be provided if personnel need to enter excavations, or they should be battered back, to comply with statutory health and safety requirements.

Where the formation comprises clays and silts it is likely that the strata will soften rapidly on exposure to weathering and, therefore, excavations should be kept open for as short a time as possible. A layer of blinding concrete may be laid to protect the base of foundation excavations. Any water accumulating in the base of foundation excavations will need pumping from a sump.

8.2.2 Foundations

Conventional strip footings will be suitable for use at this site. Based on the records of the trial pits either medium strength clays or very weak mudstone/siltstone are likely to be encountered at formation level. This should be confirmed by further investigation, once the footprint of the school is established.

The laboratory test results indicate that the clays are generally of low to intermediate plasticity although one sample plots on the boundary between intermediate and high plasticity. Based on this, the NHBC Standards (National House-Building Council, 2006) indicate that where foundations are remote from the influence of trees (existing or proposed), the minimum foundation depths should be 0.75 m and 0.9 m for low and intermediate plasticity materials respectively. If foundations are in the vicinity of either existing or proposed trees / large shrubs then the advice given in the NHBC standards should be followed to establish the appropriate founding depth. Footings may be stepped up, in accordance with the advice given in the NHBC guidelines away from the influence of the trees.

At a depth of 0.75 m, an allowable increase in bearing capacity of 100 kN/m^2 can be taken for preliminary design purposes, subject to medium strength clay being present at formation level. At this intensity of loading total settlement should be less than 25 mm and differential settlement will be less than 16 mm. The above bearing capacity is in line with presumed allowable bearing values given in BS8004: 1986 Foundations (British Standards Institution, 1986).

If higher loads are anticipated then the foundations will have to be taken deeper to found on the mudstone/siltstone encountered across the site at depths ranging from 0.5 m to 2.5 m. An allowable increase in bearing capacity of 150 kN/m^2 can be taken for preliminary design purposes, subject to weak mudstone/siltstone being present at formation level. At this intensity of loading total settlement should be less than 25 mm and differential settlement will be less than 16 mm.

8.2.3 Stability of existing and proposed slopes

No signs of instability were observed on the existing slopes and no pre-existing shear surfaces were revealed in the trial pits.

Based on the material encountered during the investigation it is considered that cut and fill slopes should remain stable with a sideslope of around 1v: 2.5h (22^o), although this should be confirmed by undertaking slope stability analyses once detailed proposals are known. The existing bund slopes adjacent to the tennis courts are at around 1v: 2.75h (20^o), but the materials used to construct them or the level of compaction, drainage measures, etc, are not known.

8.2.4 Earthworks

If earthworks are involved as part of the proposals it is likely that the majority of the materials encountered will be acceptable for use in earthworks subject to reasonable weather at the time of construction, and provided the areas of excavation are kept well-drained, i.e. free of surface water. It is advisable to compact soils in filled areas in accordance with the Specification for Highway Works (SHW) to ensure post-construction settlement is minimised.

The materials present will probably classify as SHW Class 2A, 2B, 2C or 2D material for compaction purposes (Highways Agency, 2007). It is anticipated that any unacceptable fill material will be re-usable as Class 4 landscape fill. Acceptability limits for the Raglan Mudstone are likely to be in the range 8<MCV<16, although this should be confirmed. Additional field tests may be necessary to ensure that materials with MCV towards the upper limit can be adequately compacted without the addition of water (spraying).

For trafficability, a minimum undrained shear strength of 50 kN/m^2 is recommended.

8.2.5 Retaining Walls

If retaining walls are required due to the level differences on site, then the following parameters are recommended for preliminary design purposes:

Upper clay strata

- Bulk density, γ_b = 1.8 Mg/m3
- Effective angle of shearing resistance, ϕ' = 26^o
- Effective cohesion, c′ = 0 kPa
- Co-efficient of active earth pressure, K_a = 0.39
- Co-efficient of passive earth pressure, K_p = 2.56
- Allowable increase in bearing capacity in medium strength clay = 100 kN/m^2
- Angle of base friction = 2/3ϕ' = 17^o

Mudstone / siltstone

- Bulk density, γ_b = 1.9 Mg/m3
- Effective angle of shearing resistance, ϕ' = 30^o
- Effective cohesion, c′ = 0 kPa
- Co-efficient of active earth pressure, K_a = 0.33
- Co-efficient of passive earth pressure, K_p = 3.0
- Allowable increase in bearing capacity in weak mudstone /siltstone = 150 kN/m^2
- Angle of base friction = 2/3ϕ' = 20^o

Adequate drainage should be provided behind any retaining structure to avoid the build-up of porewater pressures.

8.2.6 Concrete protection

The laboratory testing indicates that the materials present have a negligible sulphate content (0.03 g/l to 0.08 g/l) and the pH value varied from 7.0 to 7.8. Using the BRE (2005), the design sulphate class for the site is DS-1 and the aggressive chemical environment for concrete (ACEC) site classification is AC-1s. Therefore no special precautions are required to protect buried concrete.

8.2.7 Access road and parking areas

The following is given for advice purposes only and should be verified by further exploratory holes and testing once the layout of the scheme is known. The laboratory plasticity index tests indicate that the materials present generally have a low to intermediate plasticity (PI = 9 % to 28 %). Table 3.1 of Interim Advice Note 73/06 (Highways Agency, 2006) indicates that an equilibrium CBR value of around 4 % is appropriate, assuming a low water table and average construction conditions. However, the in-situ CBR values ranged from 1% to greater than 10% and based on this we recommended a preliminary design CBR value of 2% is used for areas of new construction. For a 2% design CBR value the sub-base should be a minimum of 350 mm thick. If the weather deteriorates, soft spots may develop and the sub-base may need to be thickened locally.

8.2.8 Drainage

Soakage tests were beyond the scope of this investigation and drainage proposals are not known at present. However, based on the materials encountered in the exploratory holes it is unlikely that disposal of surface water to soakaways will be feasible. Some drainage may occur in the fissured mudstone / siltstone but this should not be relied up on in the long term. If a soakaway option is pursued then it is recommended that a full soakage test is undertaken at the position of each of the soakaways to determine the infiltration rates necessary for design purposes.

8.2.9 Radon

The Radon Atlas for England and Wales (Green et al, 2002) indicates that the Wyebridge site falls within an area where only between 1% and 3% of the properties surveyed were above the radon action level. Based on this it is unlikely that radon protection measures will be required.

8.2.10 Land contamination

Following the observation of nickel contamination at various locations across the site, it is recommended that a full contaminated land investigation is undertaken in line with current guidance. The investigation should target the higher risk areas where new school building construction is proposed.

The recommended ground investigation sampling strategy should provide an equivalent grid spacing appropriate for preliminary investigations as detailed in BS10175 (BSI, 2001). Exploratory holes may include trial pits, window samples or boreholes. The investigation should also include a landfill gas survey to check the levels of soil gas concentrations (methane, oxygen and carbon dioxide).

Laboratory testing should include heavy metals (including nickel) but also include a broad screen of contaminants including petroleum hydrocarbons and asbestos. Where further contamination is observed, recommendations for remediation or risk management should be provided.

References

ATKINS LTD (2007) ATRISK^{soil} Soil Screening Level Database. Available from: http://www.atrisksoil.co.uk

BARCLAY, W.J. & SMITH, N.J.P. (2002) Geology of the country between Hereford and Ross-on-Wye – a brief explanation of the geological map. *Sheet Explanation of the British Geological Survey*. 1:50,000 Sheet 215 Ross-on-Wye (England & Wales). British Geological Survey, Keyworth.

BRANDON, A. (1989) Geology of the country between Hereford and Leominster*. Memoir for 1:50,000 Geological Sheet 198* (England & Wales). Her Majesty's Stationery Office, London.

BRE (2005) *Concrete in aggressive ground*. BRE, Report Number Special Digest 1:2005.

BRITISH GEOLOGICAL SURVEY (2000) *Ross-on-Wye. England & Wales Sheet 215. Solid and Drift Geology*, 1:50,000 Provisional Series. British Geological Survey, Keyworth.

BRITISH STANDARDS INSTITUTE (2001) BS 10175:2001. Investigation of Potentially Contaminated Sites, Code of Practice.

ENVIRONMENT AGENCY (1996) *Groundwater Vulnerability, Sheet 28 Powys,* 1:100,000, Cranfield University, Bedford.

ENVIRONMENT AGENCY AND DEPARTMENT FOR THE ENVIRONMENT, FOOD AND RURAL AFFAIRS (2002) CLR 7 *Assessment of Risks to Human Health from Contaminated Land: An Overview of Soil Guideline Values and Related Research*.

ENVIRONMENT AGENCY AND DEPARTMENT FOR THE ENVIRONMENT, FOOD AND RURAL AFFAIRS *(2002-2005) Soil Guideline Values Vol. 1–10 and 15-16*.

ENVIRONMENT AGENCY AND DEPARTMENT FOR THE ENVIRONMENT, FOOD AND RURAL AFFAIRS *(2005) CLEA Briefing Notes 1-4.*

ENVIRONMENT AGENCY (2006) *Drinking Water* [online] Available from http://maps.environment-agency.gov.uk/wiyby/ep=map~mapid=mainmap~topic=drinkingwater~layergroups=1,~layerGroupToQuery=1~lang=_e~mapOfOriginalLocation=false~scale=4~maxx=384478.28125~maxy=272177.953125~minx=316374.53125~miny=204074.203125.wiyby [accessed 11.07.07]

ENVIRONMENT AGENCY (2006) Remedial Targets Methodology – *Hydrogeological Risk Assessment for Land Contamination*.

ENVIRONMENT AGENCY (2007) *Flood Map* [online] Available from http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=floodmap&ep=map&lang=_e&x=351040.0&y=239750.0&scale=5&layerGroups=1,&layerGroupToQuery=1&location=Hereford,%20Herefordshire [accessed 17.08.07]

ENVIRONMENT AGENCY (2007) Environmental Quality Standards [online] Available from: http://www.environment-agency.gov.uk/yourenv/eff/1190084/water/1182267/1182413/290939/?version=1&lang=_e

GREEN, B.M.R., MILES, J.C.H., BRADLEY, E.J. & REES, D.M. (2002) *Radon Atlas of England and Wales*. National Radiological Protection Board. Report Number NRPB-W26.

GROUNDSURE (2007) Historical Map Pack. *Wyebridge High School, Stanberrow Road, Hereford, HR2 7NG* [CD-ROM] Groundsure.

HIGHWAYS AGENCY (2006) Design Guidance for Road Pavement Foundations (Draft HD25), *Interim Advice Note*, **73/06**, 1-62.

HIGHWAYS AGENCY (2007) Specification for Highway Works Series 0600 Earthworks. *Manual of Contract Documents for Highway Works*, **1 (0600)**, 1-74.

INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND (1990) I*CRCL Guidance Note 64/85: Asbestos on Contaminated Sites*.

NATIONAL HOUSE-BUILDING COUNCIL (2006) *Part 4.2 – Buiiding near trees* in; NHBC (2006) *Standards.* National House Building Council, Amersham.

NATIONAL RIVERS AUTHORITY (1995) *Groundwater Vulnerability of Worcestershire, Sheet 29 Powys,* 1:100,000, Cranfield University, Bedford.

OFFICE FOR PUBLIC SECTOR INFORMATION (1989, 1990) Water Supply (Water Quality) Regulations 1989, Water Supply (Water Quality) Regulations 2000.

Appendix A

Environmental Data Report, Geology & Ground Stability Report & Historical Map Pack

Appendix B

Exploratory Hole Location Plan & Fieldwork Logs

Appendix C

Laboratory Testing Results