GEOTECHNICAL AND GEO-ENVIRONMENTAL REPORT
PROPOSED REDEVELOPMENT OF FORMER POLICE TRAINING CENTRE, CWMBRAN

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APPROVED BY : ..........................

(Dr Gwyn C. Lake)
Executive Summary

The earliest historic map shows the site to be primarily field with St Dials and Little Saint Dials located in the central northern area of the site. By 1975 the Police Training Centre occupies the west of the site. A playing field is also located close to the central northern boundary. The site has remained unchanged since this time.

The 1:50,000 scale geological map (Sheet 249 Newport - Solid) shows the site to be underlain by the rocks of the St Maughans Group, which are Late Silurian in age. The British Geological Society Lexicon of Named Rock Units describes this formation as interbedded purple, brown and green sandstones with red mudstones with intraformational conglomerates containing calcrite clasts. The rocks are seen to dip to the west at between approximately 8°.

The geological map shows no superficial deposits to overlie the site. Due to the development in the west of the site and construction of the playing field areas of made ground are expected to be present.

The intrusive site investigation comprised 14 machine excavated trial pits. The trial pits found a generally thin veneer of made ground comprising mainly reworked in-situ deposits in the west of the site beneath the Police Training Centre. Over the rest of the site and beneath the made ground in the west, generally competent red brown silty clays/clayey silts and silty sands were encountered in areas grading into weathered bedrock at relatively shallow depth.

Groundwater flow is likely to prevail in a south easterly direction following the general topography of the area towards the unnamed stream located along the sites southern boundary. The bedrock is classed as a ‘Secondary A’ aquifer as are the superficial deposits.

No radon protection measures are required for the development.

In general mass concrete strip and trench fill foundations founded within the competent silty clays/clayey silts and/or weathered bedrock may be used. Based upon the site investigation data, the depth to the in-situ founding horizon will vary between 0.25 and 2.0m below the existing ground level.

For the above foundations within the given founding materials an allowable bearing pressure of 150kN/m² may be used for design purposes for a maximum total settlement of 25mm. Differential settlement of foundations should not lead to structural distortion of more than 1:750.

Due to the likelihood of a cut and fill exercise being required and the presence of swimming pool and basement structures in the Police Training Centre an alternative foundation solution in the form of a reinforced concrete founded at shallow depth was also proposed for these areas.

The chemical testing did not reveal any determinants above guideline values and it was concluded that the site could be classed as uncontaminated.
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## SECTION 1 Introduction and Proposed Development

The Ministry of Justice is proposing the sale of the former Police Training College, Cwmbran, Gwent. The site is split into the developed Police Training Centre in the west and undeveloped field land in the east.

Lambert Smith Hampton Limited is the Planning Consultants and Agents for the proposed development.

Terra Firma (Wales) Limited have been commissioned to carry out a geo-environmental assessment and geo-technical site investigation of the above site.

The main objectives of the geo-environmental assessment programme were to:

- Identify the potential environmental liabilities at the site associated with any soil and groundwater contamination from past site uses.
- Provide a summary of the environmental conditions at the site, together with any necessary remediation works to render the site fit for its intended use.
- Provide recommendations with regard to any other geo-environmental aspects pertaining to the development such as radon gas emissions.

The main objectives of the geo-technical site investigation were to:

- Determine the type, strength and bearing characteristics of the shallow superficial and underlying solid geology.
- Provide recommendations for a suitable and economic foundation/floor slab solution for the development.
- Provide recommendations with regard to any other geo-technical aspects pertaining to the development.

In order to achieve the above objectives, Terra Firma (Wales) Limited carried out an assessment programme including a review of existing data, followed by a field investigation to determine the prevailing ground conditions and also to collect and analyse soil samples from selected locations around the site.

### 1.1 Limitations and Exceptions of Investigation

Lambert Smith Hampton Limited on behalf of the Ministry of Justice has requested that a Geo-environmental Site Assessment (GSA) and Geo-technical Investigation (GI) be performed in order to determine if contamination is present beneath the site, the affect if any of radon gas, and to determine an appropriate foundation solution for the proposed development.

The GSA and GI were conducted and this report has been prepared for the sole internal reliance of the Ministry of Justice and Lambert Smith Hampton Limited. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (Wales) Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (Wales) Limited does not provide legal advice and the advice of lawyers may also be required.
1.1 Limitations and Exceptions of Investigation (Continued)

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

The site investigation was limited by the following:

- Many underground services
- Existing Buildings, roads and car parks

It was beyond the scope of Terra Firma (Wales) Limited to investigate the archaeological significance of St Dials.
SECTION 2 Review of Existing Data

2.1 Physical Setting, Current Use and Site Conditions

The site is situated close to the centre of Cwmbran, Gwent, and north of Greenmeadow Way. The site centres approximately at a National Grid Reference of 328510 196520. See Drawing 01.

The site is irregular in shape, orientated west to east, and occupies an area of 15.65 hectares. A current site layout is presented in Drawing 02.

The western area of the site is occupied by the former Police Training College comprising buildings, roads, carp parks and manicured lawn areas. The use of the various buildings is annotated on Drawing 03. The larger eastern area comprises fields separated by mature hedgerows, with a playing field located in the north side.

The topography of the eastern and central areas of the site are relatively flat ranging from 117m aod in the north and 113m aod in the central area. Ground levels drop to 96m aod in the south east corner of the site.

The site boundaries are marked by the following features:

<table>
<thead>
<tr>
<th>Direction</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern margin</td>
<td>Greenmeadow Way and associated houses</td>
</tr>
<tr>
<td>Eastern margin</td>
<td>Field boundaries</td>
</tr>
<tr>
<td>Northern margin</td>
<td>St Dials Road</td>
</tr>
</tbody>
</table>

2.2 Site History

Historical maps of the site have been obtained from the Landmark Information Group. These are presented in Annex A and the relevant editions are summarised below. Distances quoted are approximate.

1882 (1:2,500 scale)
The 1882 map shows the site to be occupied by field land separated by hedgerows, some containing mature deciduous trees. St Dials and Little St Dials are shown in the central north section of the site. Two springs are located within the centre of the site. An unnamed road forms the sites northern boundary. A Patent Nut and Bolt Works is located 250m to the north east of the site. A roughly north south trending railway is located 300m to the east of the site. Limited residential development has occurred to the 150 to 200m to the south east of the site.

1901 (1:2,500 scale)
The 1901 edition shows little change to the site from the previous edition. However, the Patent Nut and Bolt Works have increased in size and an Iron Foundry has been constructed 200m to the north of the site. Very limited residential development in the form of Arcadia Terrace, Upland Terrace and Raglan Terrace has occurred to the north of the site. The road forming the sites northern boundary is now called St Dials Road.

1920 (1:2,500 Scale)
The 1920 map shows little change to the site and surrounding area from the previous edition.
2.2 Site History (Continued)

1938 (1:10,560 scale)
The 1938 edition shows little change to the site and surrounding area from the previous map. A well is shown close to the sites south eastern boundary.

1954 (1:10,560 scale)
The 1954 edition shows little change to the site and surrounding area from the previous map. A well is shown close to the sites south eastern boundary.

1964 (1:10,000 scale)
The 1964 map again shows little change to the site and surrounding area from the previous edition, apart from the presence of a thin sliver of made ground located in the west of the site. The made ground covers an area of 20m by 8m.

1968 - 1971 (1:1,250 scale)
The 1968 - 1971 composite editions again show little change to the site, however, the area to the site has been extensively residentially developed.

1975 (1:1,250 scale)
The 1975 map shows that by this time the ‘Police Training Centre’ had been constructed in the west of the site. It is evident from the batters shown that a limited cut and fill exercise was carried out prior to construction to form level plateaux for the development. A playing field has also been constructed in the central northern area of the site. It is also evident from the batters surrounding the field that a cut and fill exercise was used to create the playing field. In the north and west of the site the ground was cut with filling taking place in the south.

1993 (1:1,250 scale)
The 1993 edition shows little change to the site from the previous map.

2006 & 2013 (1:10,000 scale)
The 2006 and 2013 maps show little change to the site from the previous edition.

2.3 Geology

The 1:50,000 scale geological map (Sheet 249 Newport - Solid) shows the site to be underlain by the rocks of the St Maughans Group of the Old Red Sandstone, which are Late Silurian in age. The British Geological Society Lexicon of Named Rock Units describes this formation as interbedded purple, brown and green sandstones with red mudstones with intraformational conglomerates containing calcrete clasts. The rocks are seen to dip to the west at approximately 8°.

The geological map does not show any superficial deposits to overlie the solid geology. However, from past experience, near the surface the St Maughans Group rocks will be completely weathered into a red brown silty clayey sand/sandy clayey silt/silty sandy clay.

Due to the past use of the western area of the site made ground mainly from re-worked in-situ materials is expected to be present.

A small fault is sown paralleling the sites southern boundary.
2.4  Radon

BRE Report Number 211 Radon: Guidance of protective measures for new buildings (2007 edition) confirms that No radon protection measures are required in the development.

The radon report is presented in Annex B.

2.5  Pollution, Waste and Groundwater

2.5.1  Hydrology

The nearest surface water feature is a small unnamed stream fed form the springs located within the site that flows in an easterly direction along the southern boundary of the site. The stream ‘sinks’ 250m to the south east of the site within residential development but is likely to flow into a partially culverted canal located 600m to the east of the site.

2.5.2  Hydrogeology

The Environment Agency database ‘What’s in your backyard?’ was consulted for information on the hydrogeology.

The bedrock beneath the site has an aquifer designation of ‘Secondary A’. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

2.5.3  Flooding

The Environment Agency ‘What’s in your backyard?’ database was searched for the risk of flooding to the site. The site does not fall within an area at risk of flooding.

2.5.4  Waste

The Environment Agency ‘What’s in your backyard?’ database was searched and it confirms the following:

There are no historic or active landfills within 250m of the site.

2.5.5  Pollution

The Environment Agency ‘What’s in your backyard?’ database was searched and it confirms the following:

Pollution Hazards

There have been no pollution incidents within influencing distance of the site.

2.5.6  Groundwater Source Protection Zone

The site does not locate within a groundwater source protection zone.
2.6 **Japanese Knotweed**

Japanese Knotweed is present in a mound of made ground located to the south of the playing filed. It approximate extent is shown on **Drawing 02**.
SECTION 3 Preliminary Risk Assessment

The following sub-sections detail a preliminary risk assessment, based upon the desk study information.

3.1 General

The contaminated land regime is set out in Part IIA of the Environmental Protection Act (EPA) 1990 and was introduced on the 1st April 2000 in England and 1st July 2001 in Wales.

Part IIA was introduced to achieve two aims:

1. The identification of contaminated land
2. The remediation of contaminated land that poses an unacceptable risk to human health and/or the environment

Under Part IIA the statutory definition of ‘contaminated land’ is:

“any land which appears to the local authority in whose area it is situated, to be in such a condition, by reason of substances in, on, or under the land, that:

(a) Significant harm is being caused or there is a significant possibility of such harm being caused; or
(b) Pollution of controlled waters is being, or is likely to be, caused.”

For land to be classified as ‘Contaminated Land’ there must be a ‘pollutant linkage’. A pollutant linkage requires three essential elements:

1. A CONTAMINANT (hazard) – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution of controlled waters
2. A RECEPTOR (target) – something which could be adversely affected by a contaminant
3. A PATHWAY – a route or means which either allows the contaminant to cause significant harm to that receptor, or that there is a significant possibility of such harm being caused to the receptor, or that pollution of controlled waters is being or likely to be caused.

The term ‘Risk’ is widely used in different contexts and situations, but a prescriptive definition is given by the Guidelines for Environmental Risk Assessment and Management (DEFRA et al, 2000):

‘Risk is a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence’.

A ‘Hazard’ is defined as ‘a property or situation that in particular circumstances could lead to harm’.

The classification of consequences and probability and determining the risk category are defined in the following sections.
### 3.2 Classification of Consequence

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
</tr>
</thead>
</table>
| **Severe**     | • Short term (acute) risk to human health likely to result in significant harm  
• Short term risk to controlled waters  
• Catastrophic damage to buildings/structures  
• Short term risk to an ecosystem or organism within the particular ecosystem |
| **Medium**     | • Chronic damage to human health (long term risk)  
• Pollution of a sensitive water resource  
• A significant change in an ecosystem or organism within the ecosystem |
| **Mild**       | • Pollution of non-sensitive water resources  
• Significant damage to buildings/structures |
| **Negligible** | • Harm (not necessarily significant) which may result in financial loss  
• Non permanent health effects to humans (easily prevented by PPE for example)  
• Easily repairable effects of structural (building) damage |

### 3.3 Classification of Probability

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
</tr>
</thead>
</table>
| **High**       | • There is a complete pollution linkage and an event appears very likely to occur in the short term and is inevitable in the long term.  
• Evidence of harm to the receptor |
| **Medium**     | • There is a complete pollution linkage which means that it probable that an event will occur  
• The event is not inevitable but possible in short term and likely in the long term |
| **Low**        | • There is a complete pollution linkage and circumstances are possible under which an event could occur  
• It is not certain that an event will occur in the long term, and it is less likely to occur in the short term |
| **Negligible** | • There is a complete pollution linkage but circumstances are such that it is improbable that an event would occur even in the long term |
3.4 Risk Assessment Matrix

By comparing the consequences of a risk and the probability of the risk of a pollution linkage, the likely risk category can be determined as shown in Table 3.3 below.

<table>
<thead>
<tr>
<th>Increasing acceptability</th>
<th>Severe</th>
<th>Medium</th>
<th>Mild</th>
<th>Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium / Low</td>
<td>Near zero</td>
</tr>
<tr>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Near zero</td>
</tr>
<tr>
<td>Low</td>
<td>High / medium</td>
<td>Medium / Low</td>
<td>Low</td>
<td>Near zero</td>
</tr>
<tr>
<td>Negligible</td>
<td>High / medium / Low</td>
<td>Medium / Low</td>
<td>Low</td>
<td>Near zero</td>
</tr>
</tbody>
</table>

**High Risk**

There is a high probability that severe harm could risk a receptor, or there is evidence that a receptor is being harmed. The risk if realised is likely to result in liability, and urgent investigation or remediation will be required.

**Medium Risk**

It is probable that harm will arise to a receptor. However it is relatively unlikely that such harm would be severe, or if harm does occur the harm is likely to be relatively mild. Investigation will be required to determine the liability, and some remedial works may be required in the long term.

**Low Risk**

It is possible that harm may arise to a receptor, but it is likely that the harm would be mild.

**Near Zero Risk**

There is a very low risk of harm to the receptor. In the event of harm being realised the harm is not likely to be severe.

3.5 Potential Sources of Contamination

The potential contamination beneath the site, whether in the matrix of soil or any groundwater will be related to the sites past use.

The west of the site is occupied by the disused Police Training College. In this area it is unlikely that heavy contamination exists. However, slight contamination may be present from made ground and hydrocarbon leakages from cars and fuel storage. Within the east of the site contamination is not expected.
3.6 Potential Receptors

The potential receptors of any contamination are taken to be:

**During Construction**
- Construction workers
- Neighbouring site users
- End users including staff and visitors
- Passers-by
- The Aquatic Environment - Surface waters and perched groundwater

**Following Construction**
- Site End Users - Staff and visitors.
- The Aquatic Environment - Surface waters and perched groundwater
- Building Materials - these are potentially at risk from aggressive ground conditions involving sulphates, sulphides, magnesium ions, ammonium ions, carbon dioxide, chloride ions and phenols.
- Vegetation upon the site is potentially at risk from phytotoxic contaminants.

3.7 Potential Pollution Linkages

The potential pollution linkages relating to human health and the protection of the aquatic environment on the site are as follows:

- Ingestion of soil and soil dust
- Inhalation of soil dust, both indoors and outdoors
- Dermal contact with soil and soil dust
- Ingestion of home grown vegetables
- Inhalation of asbestos fibres
- Inhalation of radon gas
- Surface water runoff
- Leaching into the groundwater
- Groundwater transport
- Permeation of water pipes - Organic contaminants have the potential to adsorb into plastic water pipes which may be used for drinking water supply. Toxic and corrosive contaminants may also enter the potable water source.

3.8 Qualitative Preliminary Human Health and Environmental Risk Assessment

A Qualitative Preliminary Risk Assessment (QPRA) aims to make initial assumptions about potential risks posed towards the human health and to the aquatic environment during all stages of the development. Where it is assumed that a potential pollution pathway exists, there is a potential source, a potential receptor and a likely pathway, which links the two. The QPRA can be refined into a qualitative and quantitative risk assessment once the site investigation and laboratory soil chemical testing/environmental assessment has been undertaken. The risk assessment is presented in Table 3.4 on the following page.
### 3.8 Preliminary Qualitative Human Health and Environmental Risk Assessment (Continued)

<table>
<thead>
<tr>
<th>Potential Source</th>
<th>Potential Pathway</th>
<th>Potential Target</th>
<th>Preliminary Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site Soil</strong></td>
<td>Dermal contact with soil, ingestion of soil/dust, inhalation of soil dust</td>
<td>Construction workers</td>
<td><strong>Very Low Risk</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures if required</td>
</tr>
<tr>
<td></td>
<td>Inhalation of asbestos fibres</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Site Soil</strong></td>
<td>Dermal contact with soil, ingestion of soil/dust inhalation of soil dust</td>
<td>Passers -by/neighbouring site users</td>
<td><strong>Low Risk</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Site screening and dust suppression measures where necessary.</td>
</tr>
<tr>
<td></td>
<td>Inhalation of asbestos fibres</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Site Soil</strong></td>
<td>Dermal contact with soil, ingestion of soil/dust / Ingestion of site grown vegetables</td>
<td>Site End Users – Site Residents</td>
<td><strong>Low to Moderate Risk</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potential made ground present in west of site</td>
</tr>
<tr>
<td></td>
<td>Inhalation of asbestos fibres</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Radon Gas</strong></td>
<td>Migration into indoor air</td>
<td>Site End Users – Site Residents</td>
<td><strong>No Risk</strong></td>
</tr>
<tr>
<td>from underlying</td>
<td></td>
<td></td>
<td>BGS Radon Report confirms No radon protection measures required.</td>
</tr>
<tr>
<td>bedrock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Landfill gas</strong></td>
<td>Migration through superficial deposits and bedrock and accumulation indoors</td>
<td>Site End Users – Site Residents</td>
<td><strong>No Risk</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No historic or active landfills are located within 250m from the site.</td>
</tr>
<tr>
<td><strong>Ground gas</strong></td>
<td>Direct from any made ground/buried organic matter on site and accumulation indoors</td>
<td>Site End Users – Site Residents</td>
<td><strong>No Risk</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No large areas of Made ground are expected on the site.</td>
</tr>
<tr>
<td><strong>Site Soils</strong></td>
<td>Permeation of drinking water pipes</td>
<td>Site End Users – Site Residents</td>
<td><strong>Low Risk</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No significant made ground or contamination expected.</td>
</tr>
</tbody>
</table>
### 3.8 Preliminary Qualitative Human Health and Environmental Risk Assessment (Continued)

<table>
<thead>
<tr>
<th>Potential Source</th>
<th>Potential Pathway</th>
<th>Potential Target</th>
<th>Preliminary Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aquatic Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Site Soils | Surface runoff and leaching of contamination into the perched groundwater | Perched groundwater beneath the site | Low Risk  
No significant made ground or contamination expected. |
| Site Soils | Groundwater transport | Unnamed stream to south of site. | Low Risk  
No significant made ground or contamination expected. |
| Site Soils | Groundwater transport | Underlying bedrock (St Maughans Group) | Low Risk  
No significant made ground or contamination expected. |
| **Vegetation** | | | |
| Site Soils | Uptake of phytotoxic contaminants | Vegetation | Low Risk  
No significant made ground or contamination expected. |
| **Building Materials** | | | |
| Site Soils | Damage of building materials | New buildings | Very Low Risk  
Correct class of concrete to be chosen |
### 3.9 Qualitative Preliminary Geotechnical Risk Assessment

<table>
<thead>
<tr>
<th>Potential Hazard</th>
<th>Level of Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migration of radon gas into indoor air</td>
<td><strong>No Risk</strong>&lt;br&gt;No radon protection is required for the new development.</td>
</tr>
<tr>
<td>Migration of landfill gases (methane and carbon dioxide) into indoor air</td>
<td><strong>No Risk</strong>&lt;br&gt;There are no historic or active landfills within 250m of the site.</td>
</tr>
<tr>
<td>Ground Gas</td>
<td><strong>Low Risk</strong>&lt;br&gt;No significant made ground or contamination expected.</td>
</tr>
<tr>
<td>Flooding</td>
<td><strong>No Risk</strong>&lt;br&gt;The site does not lie in an area prone to flooding</td>
</tr>
<tr>
<td>Dissolution features – underground cavities</td>
<td><strong>No Risk</strong>&lt;br&gt;The site is not in an area where natural cavities occur.</td>
</tr>
</tbody>
</table>
3.10 Preliminary Site Conceptual Model

A preliminary site conceptual model is presented below. It should be noted that the SCM is generalised and not to scale.

Figure 3.1 Preliminary Site Conceptual Model (Not to Scale)
SECTION 4  Field Investigation

4.1 Site Works

A geo-technical and geo-environmental site investigation comprising fourteen machine excavated trial pits and four soakaway tests was undertaken on the 15th May 2013.

The trial pits were excavated using two JCB 3CX mechanical excavators.

The fieldworks were supervised by two engineers from Terra Firma (Wales) Limited, who also logged the trial pits to the requirements of BS5930:1999.

The trial pit logs are presented in Annex C and their locations are shown on Drawing 02 and Drawing 03.

4.2 Exploratory Strategy

It is considered that the number and spacing of trial pits was adequate to:

• Determine the presence, nature and distribution of contamination on site in an efficient but cost effective manner.
• Optimise the chances of finding contamination hot spots of various sizes and orientations.
• Represent the chemical composition of both made ground and natural soils.
• Represent the ground conditions beneath the entire site.
• Provide sufficient data to determine suitable remedial measures if necessary.

4.3 Quality Assurance

During the intrusive investigation, small disturbed soil samples were collected.

Care was taken to ensure that sampling quality assurance occurred during site works. This included the following measures:

• The use of nitrile gloves at each sampling point.
• Stainless steel shovels were used to collect soil samples.
• The tool was cleaned with distilled water between each sample point.
• Soil samples were stored at a temperature below 4 degrees.
• No head space was left in sample containers.
• Samples were submitted for testing at the earliest available opportunity

4.4 Sampling Regime

The sampling regime was conducted in accordance with BS5930: 1999 in order to satisfy the following criteria:

• Identify and confirm suspected sources of contamination
• Determine type and concentration of contamination
• Determine lateral and vertical spread of contaminants
• Ensure representation of the entire site
• Provide sufficient data to determine suitable remedial measures if necessary

The sample locations and depths are illustrated in the table on the following page.
### 4.4 Sampling Regime (Continued)

#### Table 4.1 Sample Locations and Depths

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth (m)</th>
<th>MCERTS Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP01</td>
<td>0.5</td>
<td>Brown grey sandy CLAY</td>
</tr>
<tr>
<td>TP01</td>
<td>1.0</td>
<td>Brown grey sandy CLAY</td>
</tr>
<tr>
<td>TP02</td>
<td>0.5</td>
<td>Dark brown gravelly sandy CLAY</td>
</tr>
<tr>
<td>TP02</td>
<td>1.2</td>
<td>Dark brown gravelly clayey SAND</td>
</tr>
<tr>
<td>TP03</td>
<td>0.5</td>
<td>Brown grey sandy CLAY</td>
</tr>
<tr>
<td>TP03</td>
<td>0.9</td>
<td>Brown sandy CLAY</td>
</tr>
<tr>
<td>TP04</td>
<td>0.3</td>
<td>Dark brown grey sandy CLAY</td>
</tr>
<tr>
<td>TP04</td>
<td>1.4</td>
<td>Dark brown gravelly sandy CLAY</td>
</tr>
<tr>
<td>TP05</td>
<td>0.3</td>
<td>Brown sandy CLAY</td>
</tr>
<tr>
<td>TP05</td>
<td>1.3</td>
<td>Brown grey sandy CLAY</td>
</tr>
<tr>
<td>TP06</td>
<td>0.5</td>
<td>Brown gravelly sandy CLAY</td>
</tr>
<tr>
<td>TP07</td>
<td>0.5</td>
<td>Brown sandy CLAY</td>
</tr>
<tr>
<td>TP08</td>
<td>1.0</td>
<td>Brown sandy CLAY</td>
</tr>
<tr>
<td>TP09</td>
<td>0.5</td>
<td>Brown gravelly sandy CLAY with numerous rootlets</td>
</tr>
<tr>
<td>TP12</td>
<td>0.5</td>
<td>Brown sandy CLAY</td>
</tr>
<tr>
<td>TP14</td>
<td>1.0</td>
<td>Brown sandy CLAY</td>
</tr>
</tbody>
</table>
4.5 Ground Conditions

The ground conditions encountered by the boreholes can in general be summarised as shown in Table 4.2.

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Thickness (m)</th>
<th>Stratum</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL - 0.2/2.0</td>
<td>0.2/2.0</td>
<td>POLICE TRAINING CENTRE and PLAYING FIELD VARIABLE MADE GROUND: Generally soft in areas soft to firm red brown sandy SILT, red brown and grey green silty CLAY in areas dense clayey gravel and cobbles, gravels, cobbles, occasional brick, concrete and plastic towards the surface, with in areas tarmac surfacing</td>
</tr>
<tr>
<td>GL - 0.1/0.25</td>
<td>0.1/0.25</td>
<td>GREEN FIELD AREA TOPSOIL Comprising a soft red brown and brown sandy clayey SILT/silty CLAY, fine roots</td>
</tr>
<tr>
<td>0.2/2.0 &amp; 0.1/0.25</td>
<td>&gt;3.2 &amp; 0.1/0.25</td>
<td>BOTH AREAS Firm occasionally soft rapidly becoming firm and stiff red brown and grey green slightly sandy slightly gravelly clayey SILT/slightly sandy slightly gravelly silty CLAY, gravel increases with depth in many cases terminating in highly weathered St Maughans bedrock.</td>
</tr>
</tbody>
</table>

TP05 located in the area of the Police Training Centre encountered possible made ground to the maximum investigated depth of 3.3m.

TP10 located in the playing field encountered competent grey brown competent sandstone at 0.2m depth. The maximum depth of this pit was 0.35m due to the strength of the rock.

4.6 Water Strikes

Groundwater was encountered at the following depths:

<table>
<thead>
<tr>
<th>Location/Final Depth (m)</th>
<th>Depth of Strike (m)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP04 – 2.40</td>
<td>2.4</td>
<td>Minor seepage</td>
</tr>
<tr>
<td>TP06 – 2.10</td>
<td>2.0</td>
<td>Minor seepage</td>
</tr>
<tr>
<td>TP07 – 2.00</td>
<td>0.4</td>
<td>Vey minor seepage</td>
</tr>
<tr>
<td>TP09 – 2.00</td>
<td>2.0</td>
<td>Minor seepage</td>
</tr>
</tbody>
</table>
4.7 Laboratory Chemical Testing

The soil samples taken were despatched to the laboratories of Derwentside Environmental Testing Services for laboratory chemical testing. The following chemical tests were undertaken:

4.7.1 Soils

<table>
<thead>
<tr>
<th>Metals and Metalloids</th>
<th>In-Organics</th>
<th>Organic Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>Cyanide</td>
<td>Phenols</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Sulphate</td>
<td>PAH</td>
</tr>
<tr>
<td>Mercury</td>
<td>Cadmium</td>
<td>Speciated Petroleum Hydrocarbons</td>
</tr>
<tr>
<td>Chromium</td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>pH (acidity)</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>Asbestos</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The laboratory soil chemical test results are presented in Annex D.

4.8 In-situ Soakaway/Permeability Testing

During the site investigation four in-situ permeability tests were undertaken within trial pits TP02, TP06, TP08 and TP12 at a depth of 1.5m. The tests were carried out to the requirements of BRE 365.

No change in water level was observed during the testing period and it was concluded that shallow soakaway drainage was not viable for the development.

Deeper soakaway drainage within the underlying sandstone bedrock may be feasible but its viability would be subject to additional testing.
SECTION 5 Evaluation of Analytical Results

5.1 Methodology

Environmental risk assessment evaluates the risk to receptors via an analysis of the ‘source-pathway-target’ linkage. In order for a risk to be present, there must be a contaminant source capable of causing a health risk, a vulnerable receptor, and a pathway linking the two.

This sort of risk assessment is usually conducted using a tiered approach. Tier 1 consists of a comparison of the analytical results obtained from the site investigation with Soil Guideline Values (SGV’s) specific to the type of development obtained from The Environment Agency Contaminated Land Exposure Assessment (CLEA) Guidelines.

Where SGV values are not available reference has been made to or Generic Assessment Criteria (GAC) provided by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH).

Should Tier 1 levels be exceeded, a choice is made either to remediate the site to conservative Tier 1 levels, or proceed to Tier 2. Tier 2 makes use of site-specific data to evaluate acceptable concentrations of chemicals for the particular conditions present at the site.

At each tier, the amount and detail of investigation work increases as more site-specific data are needed to refine the characterisation of the site. Conversely, as site conditions are better understood, a more site-specific remediation strategy can be determined.

For Tier 1, the site itself is considered to be the receptor. Therefore, attenuation of contaminants between the source and receptor is not considered.

A summary of the chemical test results which include the regulatory Soil Guideline Values or Soil Screening Values used in the Tier 1 assessment is given in the tables on the following pages.
5.2 Soils

Seven samples were tested for the standard suite. Five samples from the shallow soils and two from the deeper material that showed visual and olfactory evidence of contamination. The standard suite results are shown in Table 5.1 and can be found in Annex D.

<table>
<thead>
<tr>
<th>Substance</th>
<th>SGV/GAC (mg/kg)</th>
<th>Source</th>
<th>Measured Concentrations of Tested Substances (mg/kg)</th>
<th>95% UCL</th>
<th>Number of Exceedences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>32</td>
<td>CLEA</td>
<td>1</td>
<td>4.1</td>
<td>2.449283295</td>
</tr>
<tr>
<td>Cadmium</td>
<td>30</td>
<td>CLEA</td>
<td>0.3</td>
<td>0.7</td>
<td>0.560173328</td>
</tr>
<tr>
<td>Chromium III</td>
<td>3000</td>
<td>LQM/CIEH</td>
<td>18</td>
<td>42</td>
<td>37.34527644</td>
</tr>
<tr>
<td>Chromium</td>
<td>3000</td>
<td>LQM/CIEH</td>
<td>18</td>
<td>42</td>
<td>37.34527644</td>
</tr>
<tr>
<td>Copper</td>
<td>2330^</td>
<td>LQM/CIEH</td>
<td>5.8</td>
<td>12</td>
<td>14.44528665</td>
</tr>
<tr>
<td>Lead</td>
<td>450</td>
<td>CLEA</td>
<td>6.4</td>
<td>39</td>
<td>10.94020228</td>
</tr>
<tr>
<td>Mercury</td>
<td>170</td>
<td>CLEA</td>
<td>&lt; 0.05</td>
<td>&lt;0.05</td>
<td>-</td>
</tr>
<tr>
<td>Nickel</td>
<td>130</td>
<td>CLEA</td>
<td>17</td>
<td>61</td>
<td>44.08393463</td>
</tr>
<tr>
<td>Selenium</td>
<td>350</td>
<td>CLEA</td>
<td>&lt; 0.5</td>
<td>&lt;0.5</td>
<td>0.5344125</td>
</tr>
<tr>
<td>Zinc</td>
<td>3750^</td>
<td>LQM/CIEH</td>
<td>31</td>
<td>77</td>
<td>67.75791574</td>
</tr>
<tr>
<td>Cyanide</td>
<td>8</td>
<td>CLEA</td>
<td>&lt; 0.1</td>
<td>&lt;0.1</td>
<td>-</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
<td>1.2</td>
<td>0.7923718</td>
</tr>
<tr>
<td>Sulphate</td>
<td>2400</td>
<td>BRE</td>
<td>&lt;100</td>
<td>400</td>
<td>189.19827</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>-</td>
<td>6.7</td>
<td>8.3</td>
<td>7.704144945</td>
</tr>
<tr>
<td>Total PAH</td>
<td>1.6*</td>
<td>-</td>
<td>&lt; 1.6</td>
<td>&lt;1.6</td>
<td>-</td>
</tr>
<tr>
<td>Phenols</td>
<td>420</td>
<td>CLEA</td>
<td>&lt; 0.3</td>
<td>&lt; 0.3</td>
<td>-</td>
</tr>
<tr>
<td>Asbestos</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>NAD</td>
</tr>
</tbody>
</table>

Notes:
- CLEA-Soil guideline values for a residential development
- LQM/CIEH - Generic Assessment Criteria for a residential development BRE - British Research Establishment
- A total of 16 samples were tested (5 for asbestos)
- ^ Copper and zinc threshold based on 2.5% organic matter
- * - Based upon the statistical fact that each one of the 16 EPA speciates contributes 0.1mg/kg to the total value i.e., each individual speciate is <0.1mg/kg. The most toxic speciate dibenzo(ah)anthracene has a trigger value of 0.76mg/kg
- NAD – No asbestos detected

5.2 Soils (Continued)
Selected samples taken from the former Police Training Centre were all tested for speciated PH. The results are shown below in Table 5.2.

### Table 5.2 Summary of Soil Chemical Test Results

#### Petroleum Hydrocarbons

<table>
<thead>
<tr>
<th>Substance</th>
<th>GAC (mg/kg)</th>
<th>Source</th>
<th>Measured Concentrations of Tested Substances (mg/kg)</th>
<th>95% UCL</th>
<th>Number of Exceedences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aliphatic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PH C5 – C6 Ali</td>
<td>55</td>
<td>CEIH</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>#</td>
</tr>
<tr>
<td>PH C6 – C8 Ali</td>
<td>160</td>
<td>CEIH</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>0</td>
</tr>
<tr>
<td>PH C8 – C10 Ali</td>
<td>46</td>
<td>CEIH</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>0</td>
</tr>
<tr>
<td>PH C10 – C12 Ali</td>
<td>230</td>
<td>CEIH</td>
<td>&lt; 1.5</td>
<td>&lt; 1.5</td>
<td>0</td>
</tr>
<tr>
<td>PH C12 – C16 Ali</td>
<td>1700</td>
<td>CEIH</td>
<td>&lt; 1.2</td>
<td>&lt; 1.2</td>
<td>0</td>
</tr>
<tr>
<td>PH C16 – C21 Ali</td>
<td>64,000*</td>
<td>CEIH</td>
<td>&lt; 1.5</td>
<td>&lt; 1.5</td>
<td>0</td>
</tr>
<tr>
<td>PH C21 – C35 Ali</td>
<td>64,000*</td>
<td>CEIH</td>
<td>&lt; 3.4</td>
<td>&lt; 3.4</td>
<td>0</td>
</tr>
<tr>
<td>Aromatic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PH C5 – C7 Arom</td>
<td>0.33</td>
<td>CLEA</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>0</td>
</tr>
<tr>
<td>PH C7 – C8 Arom</td>
<td>610</td>
<td>CLEA</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>0</td>
</tr>
<tr>
<td>PH C8 – C10 Arom</td>
<td>65</td>
<td>CEIH</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
<td>0</td>
</tr>
<tr>
<td>PH C10 – C12 Arom</td>
<td>160</td>
<td>CEIH</td>
<td>&lt; 0.9</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>PH C12 – C16 Arom</td>
<td>310</td>
<td>CEIH</td>
<td>&lt; 0.5</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>PH C16 – C21 Arom</td>
<td>480</td>
<td>CEIH</td>
<td>&lt; 0.6</td>
<td>9.0</td>
<td>0</td>
</tr>
<tr>
<td>PH C21 – C35 Arom</td>
<td>1100</td>
<td>CEIH</td>
<td>&lt; 1.4</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes:
- CIEH LQM - Chartered Institute of Environmental Health Land Quality Management Generic Assessment Criteria for residential land use
- CLEA - Soil Guideline Values for residential development
- A total of 5 soil samples were tested for Petroleum Hydrocarbons
- Ali - Aliphatic Hydrocarbon
- Arom - Aromatic Hydrocarbon
- CEIH LQM Based on 2.5% SOM
- # - Insufficient samples for statistical analysis

### 5.3 Contaminants of Concern in Soils

All the determinants tested fall below their respective guideline values. The site can therefore be classed as uncontaminated with regards to the substances tested for.

### SECTION 6 Quantitative Risk Assessment/Mitigation Measures
6.1 Site Summary

The earliest historic map shows the site to be primarily field with St Dials and Little Saint Dials located in the central northern area of the site. By 1975 the Police Training Centre occupies the west of the site. A playing filed is also located close to the central northern boundary. The site has remained unchanged since this time.

The 1:50,000 scale geological map (Sheet 249 Newport - Solid) shows the site to be underlain by the rocks of the St Maughans Group, which are Late Silurian in age. The British Geological Society Lexicon of Named Rock Units describes this formation as interbedded purple, brown and green sandstones with red mudstones with intraformational conglomerates containing calcrete clasts. The rocks are seen to dip to the west at between approximately 8°.

The geological map shows no superficial deposits to overlie the site. Due to the development in the west of the site and construction of the playing field areas of made ground are expected to be present.

The intrusive site investigation comprised 14 machine excavated trial pits. The trial pits found a generally thin veneer of made ground comprising mainly reworked in-situ deposits in the west of the site beneath the Police Training Centre. Over the rest of the site and beneath the made ground in the west, generally competent red brown silty clays/clayey silts and silty sands were encountered in areas grading into weathered bedrock at relatively shallow depth.

Groundwater flow is likely to prevail in a south easterly direction following the general topography of the area towards the unnamed stream located along the sites southern boundary. The bedrock is classed as a ‘Secondary A’ aquifer as are the superficial deposits.

No radon protection measures are required for the development.

6.2 Potential Contaminants/Human Health Risks

Soil chemical testing did not identify any substances in exceedence of the guideline value for a residential scenario with plant uptake:

There are therefore, no potential receptors with regards to human health.

However, construction workers should practise good site management, COSHH, good standards of hygiene, appropriate health & safety, personal protection equipment (PPE) and dust suppression.

Site screening and dust suppression measures may also be required in periods of dry weather during construction.

There is no risk from radon gas and no protection measures are required.

6.3 Aquatic Environment
The site investigation and laboratory soil analysis has shown very low concentrations of the substances tested for. Leachate will, therefore be similarly low. There is therefore, considered to be no risk to the aquatic environment

In respect of physical effects of the site works, there is a very low risk of accidental spillage of earthmoving materials/groundwater during the earthworks. During the construction phase, the following mitigation measures should be applied:

- Measures to avoid accidental spillage of materials during earthmoving activities;
- Measures to control surface run off

It should be noted that the appointed contractor should provide Method Statements and Risk Assessments in place to deal with these matters.

### 6.4 Summary of Human Health Risks

A Quantitative Risk Assessment on the potential human health effects is detailed in Table 6.1.
### Table 6.1 – Human Health Risk Assessment

<table>
<thead>
<tr>
<th>Source</th>
<th>Pathway</th>
<th>Target</th>
<th>Risk Assessment</th>
<th>Mitigation Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Made Ground/In-situ soils</td>
<td>Dermal contact with soil/dust. Inhalation and ingestion of soil/soil dust</td>
<td>Construction workers</td>
<td>No Risk</td>
<td>COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures/measures to deal with asbestos.</td>
</tr>
<tr>
<td>Made Ground/In-situ soils</td>
<td>Dermal contact with soil/dust. Inhalation and ingestion of soil/soil dust</td>
<td>Neighbouring site occupants, Passers-by</td>
<td>No Risk Contamination not indicated</td>
<td>N/A</td>
</tr>
<tr>
<td>In-situ soils</td>
<td>Dermal contact with soil/dust. Inhalation and ingestion of soil/soil dust</td>
<td>Site end users</td>
<td>No Risk Contamination not indicated</td>
<td>N/A</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Inhalation</td>
<td>Construction Workers</td>
<td>No Risk</td>
<td>No asbestos found</td>
</tr>
<tr>
<td>Ground Gas</td>
<td>Inhalation</td>
<td>Site end users</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
<tr>
<td>Landfill Gas</td>
<td>Inhalation</td>
<td>Site end users</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
<tr>
<td>Radon Gas</td>
<td>Inhalation</td>
<td>Site end users</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
<tr>
<td>Hydrocarbon Vapours</td>
<td>Inhalation</td>
<td>Construction workers and site end users</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A - Not applicable

### 6.4 Summary of Human Health Risks (Continued)
During the ground works, the contractor should comply with all current Health and Safety regulations.

If during the development unexpected materials or abnormal ground conditions are encountered that are significantly different to those encountered in the investigation, the occurrence should be reported to the Engineer and appropriate action taken prior to continuing with the works.

Reference should be made to the Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (Report Reference Number 10/WM/03/21. The local water supplier should be contacted for further information.

### 6.5 Summary of Risks to the Aquatic Environment

A Qualitative Risk Assessment on the potential effects to the aquatic environment is detailed in Table 6.2.

<table>
<thead>
<tr>
<th>Source</th>
<th>Pathway</th>
<th>Target</th>
<th>Risk Assessment</th>
<th>Mitigation Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-situ soils</td>
<td>Surface water Leaching into Groundwater /runoff</td>
<td>Unnamed stream to south of the site Groundwater</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
<tr>
<td>Made Ground</td>
<td>Surface water Leaching into Groundwater /runoff</td>
<td>Groundwater</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
<tr>
<td>Hydrocarbon contamination</td>
<td>Surface water Leaching into Groundwater /runoff</td>
<td>Unnamed stream to south of the site Perched Groundwater Groundwater</td>
<td>No Risk</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A – Not applicable

### 6.6 Refined Preliminary Site Conceptual Model
The site conceptual model (SCM) is presented below. It should be noted that the SCM is generalised and not to scale. Many of the variables on the site are still unknown and the SCM below is therefore a refined version of the preliminary SCM.

**Figure 6.1** Refined Preliminary Site Conceptual Model (Not To Scale)

**SECTION 7** Engineering Recommendations

**7.1** Preparation of Site
Prior to the main works commencing, a suitable asbestos survey should be undertaken on the Police Training Centre Buildings. Any deleterious materials encountered should be removed by specialist contractors to a suitably licenced landfill facility as per HSG 264.

Allowances should be made for the removal or treatment of the Japanese Knotweed identified to the south of the playing field. The removal or treatment of the knotweed should be undertaken to current legislation.

Further allowances should be made for the infilling of the former swimming pools and basement structures associated with the former boiler house located in the police training centre. Prior to infilling holes should be punched in the floors to prevent the build-up of ground water. The pools and basement structures should be infilled in layers with well compacted imported inert granular materials. Department of Transport (DoT) Type 2 sub-base or similar may be used and should be compacted in layers, in accordance with the Specification for Highway Works. Alternatively, appropriate selected inert imported fill could be used.

Contingencies should be made for the removal of the fuel storage area.

All tarmac, top soil, scrub vegetation and trees including all roots and hard standings should be removed from beneath the footprint of the proposed buildings.

The reduced levels should be brought up to the required levels with well, compacted imported granular materials as previously described

Allowances should be made for removing any ‘soft spots/area’ and their replacement with well compacted granular materials.

Contingencies should also be made for the protection/diversion of any underground services present beneath the site brought about as a result of the proposed works.

Further contingencies should be allowed for ‘picking up’ the springs located on site and incorporating them into the proposed storm drainage systems.

In accordance with EC Regulation 1272/2008 and Environment Agency Guidance WM2 (v. 2.3/2011) soils and other materials destined for off-site disposal should be classified on the basis of their hazard phrases and specific chemical properties prior to disposal.

Due to the sloping nature of the site particularly in the south east of the site in order to provide level plateaux for the proposed development a cut and fill exercise will be required.

Steepening of the existing hillside is not recommended. Retaining walls will therefore be required.

In order to maintain stability it is recommended that the hillside is cut in small sections and the retaining walls constructed in prior to cutting adjacent sections.

Adequate drainage should be incorporated behind the walls in order to prevent the build-up of hydrostatic pressure.

Prior to placing any fill onto the existing hillside should be adequately cut and benched in order to prevent a predetermine slippage plane being formed.

7.1 Preparation of Site (Continued)
For a new cuttings and/or filled areas drainage should be provided at the top and bottom of the slopes in order to prevent erosion.

The slopes should also be top soiled and grass seeded to further prevent erosion form surface water run-off.

7.2 Foundation and Floor Slab Solution

In general a combination of mass concrete strip and trench fill foundations founded within the firm and stiff red brown clays/silts and sands may be used.

Based upon the site investigation data, the depth to the in-situ founding horizon will vary between 0.25m and 2.0m below the existing ground level.

For the above foundations within the given founding materials an allowable bearing pressure of 150kN/m$^2$ may be used for design purposes for a maximum total settlement of 25mm. Differential settlement of foundations should not lead to structural distortion of more than 1:750.

In order to prevent damage from frost heave and/or thermal shrinkage the foundation formations should extend down to 900mm below the finished ground level, and foundations should penetrate at-least 200mm in to the founding horizon.

Allowances should be made for removing any ‘soft spots/areas’ and their replacement with well-compacted imported granular materials as previously described.

The floor slabs can be designed as suspended.

In addition, it should be noted that deeper foundation depths than those quoted above may be required close to the tree root system of the trees located around the site. The National House Building Council (NHBC) gives guidelines on the depth of foundation depending upon the type of tree, distance from the tree and plasticity of the soil.

Based upon past experience, the in-situ materials will have a low to moderate shrinkage potential.

For any new build located over the old swimming pools/basements or where deep made ground is encountered such as in TP05 consideration should be given to the use of a reinforced concrete raft type foundation floor slab solution founded at a minimum depth below ground level of 900mm.

For the above foundations within the given founding materials an allowable bearing pressure of 75kN/m$^2$ may be used for design purposes for a maximum total settlement of 25mm. Differential settlement of foundations should not lead to structural distortion of more than 1:750.

If after any cut and fill exercise the depth to the in-situ founding horizon becomes prohibitive then the above raft type foundation floor slab solution with similar bearing pressures and settlements can be used.

All foundation formations should be inspected by a suitably qualified engineer before being concreted.

7.3 Excavations and Formations
Most shallow excavations should be possible with normal soil excavating machinery. However, allowances should be made for the use of hydraulic breaker attachments when excavating historic foundations or obstructions associated with the former buildings and shallow bedrock.

Slight ground water was encountered between 0.4 and 2.0m. These inflows should be dealt with by conventional pumping techniques. During times of high rainfall the water table can rise and allowances should also be made for seasonal fluctuations.

The sides of any excavations deeper than 1.0m should be supported by planking and strutting or other proprietary means as trial pit wall collapse was noted in one of the trial pits.

The sub-formations/formations will be susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations and as a minimum the formation/excavation surfaces must be protected by a minimum thickness of 200mm of hard cover immediately after exposure.

Allowances should be made for the removal of soft spots/areas and their replacement with well compacted granular materials.

Allowances should be made for special precautions to prevent formation deterioration in addition to the above.

It is recommended that approval be gained from a qualified engineer of the formation condition before covering them with any subsequent construction.

### 7.4 Access Roads and Car Parking Areas

For access roads and car parking formations within the in-situ materials a CBR Value of 1\% may be used for design purposes. For access roads and car parking areas within well compacted made ground materials or more competent in-situ materials an increased CBR value of 4\% may be used.

Allowances should be made for the removal of any ‘soft spots/areas’ and their replacement with well-compacted granular materials as previously described.

It should be noted that the Local Highway Authority may require field in-situ CBR Tests to be carried out at formation level. Depending upon the results of such tests the above recommendations can be reviewed and if necessary amended.

### 7.5 Protection of Buried Concrete
The laboratory soil chemical tests revealed total sulphate contents of <100 mg/kg to 400 mg/kg and pH values of between 6.7 and 8.3.

All buried concrete should as a minimum conform to Class AC-1 of BRE Special Digest 1:2005.

### 7.6 Retaining Walls

Due to the sloping nature of the site and the cut and fill exercises that will be necessary to create a level development plateau, retaining walls will be required.

The effective angles of shearing resistance of the encountered materials have been determined based upon past experience of the materials. Laboratory testing of representative soil samples should be undertaken at a future date to confirm the quoted parameters.

<table>
<thead>
<tr>
<th>Stratum Description</th>
<th>Bulk Unit Weight (γ) kN/m³</th>
<th>Effective Cohesion (c') kN/m²</th>
<th>Effective Angle of Shearing Resistance (ϕ') degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft to firm CLAYS</td>
<td>18 - 20</td>
<td>0</td>
<td>20 – 25</td>
</tr>
<tr>
<td>Firm to stiff/very stiff CLAYS</td>
<td>18 - 20</td>
<td>0</td>
<td>25 - 30</td>
</tr>
<tr>
<td>Medium dense and dense GRAVELS/SANDS</td>
<td>19 - 20</td>
<td>0</td>
<td>25 - 30</td>
</tr>
<tr>
<td>Well compacted, granular materials,</td>
<td>19 - 22</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>compacted as per Specification for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway Works and other relevant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>guidance such as British Standards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competent St Maughans Group Bedrock</td>
<td>22</td>
<td>15</td>
<td>50</td>
</tr>
</tbody>
</table>

The design and construction of the retaining walls and cut and fill should be in accordance with BS 6031: 1981 Code of Practise for Earthworks and other relevant guidance.