WYG Environment
part of the WYG group

Defence Estates

Proposed Service Family Accommodation at Picketston South West, RAF St Athan

Ground Conditions Assessment Report

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SUMMARY

The Site	The site is located in a predominantly agricultural area approximately 250m to the north of RAF St Athan and 25km west of Cardiff. The site consists of a series of five fields divided by hedgerows, access is via a lane to the north.
Site History	Since the earliest available mapping (1886), the site is shown to be part of a wider field system. The western part of the site is also shown to be used for leisure activities associated with RAF St Athan. The surrounding site was predominantly agricultural until the development of RAF ST Athan.
Geology, Hydrogeology, Hydrology and Radon.	The site is underlain by strata from the Porthkerry Formation of the Lower Lias Group, consisting of thinly bedded limestone and clay. The Porthkerry Formation is classified as a Secondary (formerly Minor) Aquifer the soils in the area are classified as having a high leaching potential. The closest surface water body is Boverton Brook, which runs adjacent to the southern boundary of the site. The site is located in an area where full radon protection measures may be required in new dwellings.
WYG Intrusive Investigation	An intrusive ground investigation was undertaken by WYG in October 2010 and consisted of fifteen machine excavated trail pits, four boreholes with groundwater and landgas monitoring installations, insitu testing (permeability) and associated laboratory testing (geotechnical and chemical)
Ground Conditions Encountered	The ground conditions encountered comprised topsoil over sandy gravelly clay overlying limestone bedrock of the Porthkerry Formation. Ground conditions were similar across the entire site. Groundwater was encountered in four exploratory positions at the interface between the clay and underlying limestone bedrock and was present within all standpipes at depths of 0.5 to 2.7m bgl (38 to 41m OD).
Geotechnical Assessment and Recommendations	Spread foundations should bear onto the limestone bedrock of the Porthkerry Formation and may be designed to a net allowable bearing pressure of 250kPa, which should limit settlement to less than 20mm for strip footings of not more than 0.6m wide. Floor slabs bearing onto either stiff fine grained deposits or limestone bedrock of the Porthkerry Formation may be ground bearing for combined dead and live loads of up to 15kPa and may be expected to settle less than 10mm. The Aggressive Chemical Environment for Concrete (ACEC) site classification should be taken as AC-2s. It is recommended that a design CBR of 3% can generally be applied across the site where pavements are constructed directly onto the fine grained soils of the Porthkerry Formation. Foundation and services excavations may require a breaker and highly rated plant to achieve required depths. It is not anticipated that significant dewatering will be required for foundation excavations.
Ground Contamination Assessment and Recommendations	Taking into account the environmental setting of the site as well as the current and proposed development the overall risk rating for the site is considered to be of a low order. The site is located in an area where radon protection measures may be required in new dwellings and as such the risk associated with radon if deemed to be of a high order. However, the risk can be managed by obtaining a site specific risk assessment and subsequently implementing the level of protection measures detailed within this report. Land gas monitoring and subsequent assessment indicates that land gases (methane and carbon dioxide) pose a very low risk to development.

1.0 INTRODUCTION

1.1 Instruction

WYG Environment (WYG) was commissioned by WYG Management Services on behalf of Defence Estates to undertake a geo-environmental ground conditions assessment for four separate sites located within the RAF St Athan area, South Wales. This report details the assessment carried out for the 'Picketston South West' site only; the assessments for the remaining three sites are reported by WYG separately. The location of the Picketston South West site is shown in Figure 1 and the general layout of the RAF St Athan area is shown in Figure 2.

1.2 Proposed Development

The outline proposed development is presented in Appendix H and comprises a residential development with associated private gardens, infrastructure and soft landscaping. The residential development comprises service family's accommodation (SFA) for RAF St Athan. The final layout of the development was not available at the time of investigation and reporting.

1.3 Brief

The brief was to undertake a combined ground contamination and geotechnical intrusive ground investigation following on from the Geo Environmental Desk Study Report prepared by WYG in February 2009. The brief also included provision of an updated ground contamination and geotechnical ground conditions assessment with outline foundation and remediation/risk management (if required) recommendations and/or recommendations for further investigation/assessment.

1.4 Report Scope

This report provides the following key elements:

- A summary of the previous geo environmental desk study carried out by WYG.
- A summary of the rationale and scope of ground investigation work undertaken by WYG in October 2010.
- A discussion of ground conditions encountered beneath the site.

- A discussion of the engineering properties of ground conditions encountered.
- A geotechnical appraisal of the ground conditions encountered together with outline foundation recommendations.
- A ground contamination assessment of ground conditions encountered including a Tier 1 Generic Quantitative Risk Assessment and qualitative risk assessment in accordance with CIRIA 552.
- Recommendations for any further investigation and/or remediation/risk management if required.
- An executive summary of the report to allow a rapid, layman's overview.

1.5 Client Supplied Information and Report Control

WYG has been provided with copies of numerous reports spanning the past 10 years which detail previous investigation work carried out by other consultants within the wider St Athan area. These reports were reviewed as part of the previous geo environmental desk study work reported by WYG in February 2009 and the WYG 'Review of Environmental Work Streams' dated July 2008, and are referred to herein where deemed appropriate.

1.6 Limitations

This report is subject to the Terms and Conditions of Engagement as stated in Appendix A at the end of this report.

The information contained in this report is intended for the use of Defence Estates and their Consultant partners; WYG can take no responsibility for the use of this information by any third party or for uses other than that described in this report or detailed within the terms of our engagement.

2.0 SITE INFORMATION

2.1 Site Location

The site is centred on National Grid Reference 299290, 169340 with access to the site currently from a lane to the north of the site. The site is situated in a predominantly agricultural area, approximately 250m to the north of RAF St Athan, 25km west of Cardiff. A site location plan is presented at the end of this report as Figure 1.

2.2 Site situation and description

The site is irregularly shaped and is comprised of five fields which are divided by a series of hedgerows. The southern boundary of the site is not marked on the ground. The fields are currently used as grassed land and for the production of arable crops. The site is located approximately 250m north of the 'North of West Camp' site which is also currently being considered for development as part of RAF St Athan and is subject to a separate report.

Assess to the site is via a lane/track to the north of the site.

2.2.1 Surrounding Land Uses

The surrounding land uses are summarised in the table below.

Table 1 Surrounding land uses

North	Agricultural fields, beyond which is a disused area of RAF St Athan
East	Agricultural fields. RAF St Athan is located approximately 200m to the east of the site
South	Agricultural fields. RAF St Athan is located 140m to the south.
West	Agricultural fields. Static caravan site is located 150m to the west of the site.

2.3 Site History

A detailed review of site history is presented in the previous WYG desk study report. A summary of the historical review is provided below.

On site land use history:

From the earliest mapping in 1886, the site is shown as agricultural and is divided into five fields. Mapping dated 1993, indicates that the far western field is being used for leisure activities associated with RAF St Athan air base adjacent to the site.

Off site land use history:

The surrounding area is shown to be predominantly agricultural from the earliest mapping (1885). In Air Ministry plans dated 1946, the development of RAF St Athan approximately 250m to the south of the site is shown and road network immediately adjacent to the eastern boundary of the site is labelled as 'R&D Park'. By 1946 further expansion of RAF St Athan is shown with an air field located approximately 500m east of the site.

2.4 Published Geology

The geology of the site area is covered by British Geological Survey 1:50,000 mapping of the Bridgend area, Sheet No. 262 (solid and drift). The mapping indicates that the site is underlain by the Porthkerry Formation which forms part of the Lower Lias Group. The geological memoir which accompanies the map shows that the Porthkerry Formation consists of thinly bedded limestone and clay and can be in excess of 120m thick.

2.5 Published Hydrogeology

The hydrogeology of the site area is detailed in the Environment Agency map 'Groundwater Vulnerability of Gwent, South and Mid Glamorgan', Sheet 36. This map classifies the ground beneath the site as a Secondary Aquifer (formerly referred to as a Minor Aquifer). Secondary Aquifers are variably permeable and although they do not produce large quantities of water for abstraction, they can be important for local supplies and in supplying base flow to rivers. Soils in the area are classified as having a high leaching potential.

The site is not located within an Environment Agency designated Source Protection Zone (SPZ).

2.6 Hydrology

The closest surface water course is the Boverton Brook which, at its closest is located 90m to the south of site and trends from east to west. An unnamed ditch located 25m to the east of site flows south into the Boverton Brook. The Llanmaes Brook is also a tributary to the Boverton Brook and is located approximately 560m to the west of site.

Environment Agency flood mapping indicates that the site is not in an area of potential flooding from rivers or the sea.

2.7 Radon

Based on the mapping included in BRE document 211, Radon: Guidance on Protective Measures for New Dwellings – 2007' the site is located in an area where full radon protection measures may be required for new dwellings. It is therefore recommended that a site specific BRE211 Radon Report is obtained for the site which will provide guidance on the level of radon protection measures required for the site (if any).

2.8 Environmental Database

A detailed review of an environmental database provided by Landmark Information Group is provided in the WYG desk study report. A summary of the notable features is presented below.

- There are three consents for the discharge of trade effluent to the Boverton Brook and one consent for trade effluent to Nant y Stepau associated with RAF St Athan within 500m of the site.
- There is one water abstraction record located 260m south of the site which is associated with pollution remediation.
- There are no active of historic landfill sites within 1km of the site.
- There are no sensitive land uses within 1km of the site.

In addition, the contaminated land officer at Vale of Glamorgan County Borough Council was contacted on the 19th November 2008 and 15th December 2008 to request any information the council hold within their database that is deemed relevant to the site and any development. The contaminated land officer highlighted a number of small quarries both on site and in the vicinity of the site but that these had not been prioritised under Phase I of the local authority inspection strategy and the council has no current concerns regarding these sites.

The Environment Agency was also contacted who stated that they have no specific record of the site or adjoining land being contaminated. However this does not guarantee that no land contamination is present at the site, and it would be prudent to investigate the historical land uses of the site and its surroundings to ascertain whether any past activities may have caused land contamination to have taken place.

2.9 Radiation

A radiological risk assessment was previously undertaken for an area in the north west of the wider St Athan site (Sales Field and R&D area – See Figure 2) by Enviros Limited in May 2003 (RAF St Athan Extension Areas Radiological Assessment). This report indicated hotspot areas of elevated levels of radiation which were subsequently remediated by Parsons Brinkerhoff (Remediation of land at RAF St Athan, 2004) through the removal of the top 0.3m of soil and subsequent screening and disposal of materials which indicated elevated levels of radiation within the soil. The survey area overlaps with the eastern boundary of the current site and as such a scintillometer was used as a personal monitor for operatives on site and to screen samples before removal form site.

2.10 UXO (Unexploded Ordnance)

A desk based assessment of the wider area around the site, focussed on activity around RAF St Athan was previously presented by Parsons Brinkerhoff (RAF St Athan, Explosive Clearance and Development Desktop Study) in 2008.

The area covered by the site was given a low risk rating. The report recommends that prior to any excavation being undertaken, all personnel should be provided with ordnance awareness training and a trained UXO expert should be available for call out.

3.0 SCOPE & RATIONALE OF WYG FIELDWORK

An intrusive site investigation was undertaken by WYG Environment between 8th and 13th October 2010. Details of the fieldwork methods used are given in the Notes section at the end of this report. The scope of the works is outlined below.

- Fifteen machine excavated trial pits were advanced to depths of between 0.42m and 1.80m below ground level (bgl). The pits were undertaken to provide general coverage of near surface ground conditions across the site.
- Four windowless sample/rotary cored boreholes were advanced to depths of between 4.0m and 5.50m bgl with in situ SPT (standard penetration testing) testing. Window sampling was carried out through superficial deposits and coring / open hole drilling was carried out within the bedrock in some locations.
- Land gas and groundwater monitoring installations were constructed within all of the rotary cored/windowless sample boreholes.
- Soakaway tests were undertaken in two additional trial pits, SAW201 and SAW204.
- Laboratory geotechnical and chemical testing.
- Three return land gas monitoring visits
- A single return groundwater monitoring visit.

Figure 4 shows the layout of the exploratory holes. Engineering logs are presented in Appendix B of this report, monitoring data is presented in Appendix C, soakaway test data are presented in Appendix D, geotechnical test results are presented in Appendix E and chemical results are presented in Appendix F.

4.0 GROUND CONDITIONS ENCOUNTERED.

4.1 Soil Conditions

The sequence of strata beneath the site has been determined from observations made during the intrusive site investigation.

- Topsoil
- Cohesive Deposits (Porthkerry Formation)
- Limestone (Porthkerry Formation)

Depths and thicknesses of the various strata encountered are summarised in the table below.

Table 2 – Summary of Ground Conditions Encountered

Exploratory Position	Topsoil (mbgl)	Cohesive Deposits (Porthkerry Formation) (mbgl)	Limestone (Porthkerry Formation) (mbgl)*
BH202	-	GL – 0.80	0.80 - 4.50
BH203	-	GL – 0.90	0.90 – 5.50
BH207	-	GL – 0.60	0.60 – 4.00
BH208	-	GL – 0.50	0.5 – 4.00
TP201	GL – 0.15	0.15 – 0.70	0.70 – 0.87
TP202	GL – 0.10	0.10 – 0.20	0.20 – 0.45
TP203	GL – 0.25	0.25 – 0.42	0.42
TP204	GL – 0.15	0.15 – 0.35	0.35 – 0.55
TP205	GL – 0.25	0.25 – 0.44	0.44
TP206	GL – 0.20	0.20 – 0.55	0.55 – 0.82
TP207	GL – 0.25	0.25 – 0.62	0.62
TP208	GL – 0.25	0.25 – 0.45	0.45 – 0.80
TP209	GL – 0.25	-	0.25 – 0.67
TP210	GL – 0.25	0.25 – 0.45	0.45 – 0.70
TP211	GL – 0.15	0.15 – 1.80	1.80
TP212	GL – 0.20	0.20 – 0.50	0.50 – 1.10
TP213	GL – 0.15	0.15 – 0.75	0.75 – 1.10
TP214	GL – 0.20	-	0.20 – 0.95

* denotes base not encountered

4.1.1 Topsoil

Topsoil was encountered in all investigation positions, and ranged in thickness between 0.1m and 0.25m. It was uniform in composition and consisted primarily of clay. Consistencies varied between firm and stiff.

4.1.2 Fine Grained Deposits (Porthkerry Formation)

Cohesive Deposits were encountered in all locations except TP214 and ranged in thickness between 0.10m and 1.65m. A clay layer was identified in TP209 beneath limestone cobbles at 0.6 to 0.67m. It was generally uniform in composition and consisted primarily of sandy gravelly clay with occasional cobbles of limestone. Consistencies varied between firm and stiff. It is presumed that this residue soil has been derived from the weathering of the Porthkerry Formation.

4.1.3 Limestone (Porthkerry Formation)

Limestone of the Porthkerry Deposits was encountered in all investigation positions, and was encountered at a depth of between 0.2m and 1.5m.

During trial pitting, the limestone was generally recovered as angular cobbles of limestone with a minor constituent of brown clay in weathered horizons. Rock cores obtained from boreholes BH202, BH203, BH207 and BH208 comprised strong grey slightly, locally moderately to moderate weathered limestone with closely spaced horizontal to vertical fractures with silt or clay infill.

4.2 Soakaway testing

Two soakaway tests were undertaken, denoted as SAW201 and SAW204, the calculation sheets for which are presented in Appendix D. SAW301 and SAW305 were undertaken in the limestone deposits of the Porthkerry Formation and produced infiltration rates (f) of 6.19 x 10^{-6} m/s and 1.21 x 10^{-6} m/s, indicating low permeability and poor drainage conditions.

4.3 Obstructions

Underground obstructions were not encountered in any of the exploratory locations. Limestone bedrock was encountered in all locations.

4.4 Visual / olfactory evidence of contamination

No visual or olfactory evidence of potential contamination was identified during the site investigation or subsequent groundwater monitoring.

4.5 Asbestos

Suspected asbestos containing materials (ACM) were not identified either on the ground surface or within soil arisings during the site investigation.

4.6 Groundwater

Groundwater flows were observed at depths of 1.1m to 1.8m in TP211, TP212 and TP213. It was also observed in BH203 at 2.00m. All strikes were recorded within or on the fine grained / bedrock interface of the Porthkerry Formation.

Groundwater monitoring was also undertaken during three return visits and the results are summarised in the table below.

Table 2 Summary of groundwater monitoring results

Exploratory Position	Strata Unit Screened	Base of Borehole (mbgl)	8th November 2010 (m bgl)	16th November 2010 (m bgl)	23rd November 2010 (m bgl)
BH202	Porthkerry Formation	4.50	2.70	1.85	1.92
BH203	Porthkerry Formation	5.50	0.60	0.50	0.60
BH207	Porthkerry Formation	4.00	2.50	2.30	2.40
BH208	Porthkerry Formation	4.00	2.95	2.70	2.80

4.7 Land Gas Monitoring

Monitoring installations were constructed within the all of the rotary cored/window sample boreholes across the site to depths of between 4.0m to 5.50m bgl. Details of the various installations are presented in Table 2.

Three return monitoring visits were undertaken on 8th, 16th & 23rd of November 2010 and the results collected from the site have been assessed within this report as presented in Section 9.0. Carbon dioxide concentrations of up to 0.9% by volume were recorded. Methane was not detected at levels above the limit of detection of the instrument. Gas flow rates of <0.1l/hr were recorded.

4.8 Radiological Monitoring

A personal radiation monitor was used on site in order to provide a record of levels of radiation present on site. In addition, all samples were screened by a scintillometer prior to removal from site. During the WYG site investigation, no radiation was detected above background values for the surrounding area.

5.0 LABORATORY TESTING

5.1 Geotechnical testing

A programme of laboratory testing was carried out on samples taken from the various strata to determine the engineering properties of the materials underlying the site. The testing was scheduled by WYG and carried out by Geo Laboratory Testing Services Limited which is an approved supplier in accordance with the requirements of WYG quality system and is UKAS accredited for a range of geotechnical tests.

The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given below:

Table 3 Summary of Geotechnical Testing Suite - Soils:

TEST	STANDARD (BS1377:1990)	No.
Moisture Content	Part 2, Clause 3.2	7
Liquid Limit (cone penetrometer method)	Part 2, Clause 4.3	7
Plastic Limit	Part 2, Clause 5.3	7
Plasticity Index	Part 2, Clause 5.4	7
Particle size distribution	Part 2, Clause 9.2	2
BRE SD1Suite	Part 3 and BRECP2/79	3
Determination of CBR	Part 4, Clause 7	3
Point Load Index (Rock)*	ISRM suggested method	4
Unconfined Compressive Strength (Rock)*	ISRM suggested method	4

* not BS tests

Laboratory geotechnical test results are presented in Appendix E.

5.2 Chemical testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by WYG. The testing was carried out by Scientifics Limited which is an approved supplier in accordance with the requirements of WYG quality system and is UKAS accredited for a range of chemical analyses.

The following suite of determinands were tested for on 9 soil samples, 2 soil derived leachate samples and 2 water samples.

Table 4 Summary of typical chemical testing suite (soils, soil derived leachate and water samples)

- Boron (H_20 Soluble)
- Antimony
- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Molybdenum
- Nickel
- Selenium
- Zinc
- Barium
- Beryllium.
- Iron
- SO4-- (H_2O sol)
- pH units
- Cyanide(Free)
- Phenol Index.
- Asbestos Screen
- Tot.Moisture @ 105C
- DRO by GCFID
- TPH by GCFID
- Exchange.Ammonium
- Chromium vi:
- MTBE
- Total Organic Carbon
- Phenol
- Cresols
- Xylenols
- Trimethylphenols
- Total Phenols
- Speciated PAH (16 USEPA)
- Total (USEPA16) PAHs
- Phenol
- Fractionated TPH (CWG Aliphatic Aromatic C_5-C_{40})
- Benzene
- Toluene
- Ethylbenzene
- m and p-Xylene
- o-Xylene

Laboratory chemical test results are presented in Appendix F at the end of this report. A discussion of the test results is presented in Section 8.0.

6.0 GROUND ENGINEERING PROPERTIES

6.1 Ground conditions

Ground conditions have been assessed to be consistent across the site and generally comprised a thin layer of Topsoil overlying predominately cohesive deposits overlying Limestone bedrock. The lithological variations encountered have been summarised in Section 4.0.

6.2 Soil Properties

The ranges of the various soil properties measured are discussed below, to aid in the selection of design values. However, the appropriate choice of characteristic and design values will depend on the particular analysis and design philosophy used, and should be selected by the designer. It should be noted that test data collated from the site have been used to inform the discussion below.

6.2.1 Cohesive Deposits (Porthkerry Formation)

The geotechnical properties of the fine grained soils of the Porthkerry Formation are summarised in Table 5 based on field observation, field tests and laboratory tests.

Table 5 Summary of geotechnical properties – Fine Grained Deposits (Porthkerry Formation)

		No. of results	Range (min-max)	Average	Lower quartile	Upper quartile	Charact-eristic value+
Natural moisture content (m - %)		7	18 – 36	30	25	36	25
Liquid limit (LL)		7	42 – 64	53	42	59	59
Plastic limit(PL)		7	17 – 38	30	17	36	36
Plasticity index (PI)		7	20 – 27	23	20	24.5	24.5
Modified Plasticity index (PI_m %)		7	19-25	21	19	23	23
Liquidity index (LI)*		7	-0.14 – 0.13	-0.03	-0.14	0	-0.14
Undrained shear strength:							
- from hand vane	**c** (kPa)	24	68->120	98	85	120	85

CBR (%)	**Mexe Cone**	23	1 - 14	5.5	2	8.75	3%
	Laboratory Derived	2	1.8-4.4	3.1	1.8	3.8	

Notes: * Liquidity index (LI) is defined as: LI = (m – PL)/PI;
+ suggested characteristic values are appropriate for most normal applications but designers should satisfy themselves that they are suitable for the specific application and design method they are using.

These results above correspond to a clay soil of intermediate to high plasticity. A modified plasticity of 31% equates to a soil of medium volume change potential.

Chemical testing was undertaken on three samples of the cohesive deposits to allow the assessment of ground aggresivity on concrete. The results are presented in the table below.

Table 6 Chemical Test data for Assessment of Ground Aggresivity on Concrete

Location	Depth (mbgl)	Acid soluble sulphate as % SO_4	Aqueous extract sulphate as % SO_4	Soluble Chloride (%)	pH value	Total Sulphur %	Magnesium (g/l)	Nitrate (mg/l)
TP211	1.20	0.03	0.01	NCP	7.88	0.11	<1	<10
TP212	0.70	0.09	0.01	NCP	7.40	0.31	<1	<10
TP215	0.80	0.02	<0.01	NCP	7.31	0.12	<1	<10

6.2.2 Limestone bedrock (Porthkerry Formation)

Where poor core recovery was identified in the upper horizons (top 2m), Standard penetration tests (SPT's) were undertaken. Of the five SPT tests, one did not achieve full penetration after 50 blows. However, the remaining four recorded N values of 39, 41, 46 and 49 and probable represent highly fractured limestone bands and/or clay bands/infill within the formation, as evidenced visually, see Section 4.1.3.

In order to take into account the weaker horizons locally encountered in the upper parts of the Porthkerry Formation, it is recommended that it be considered a clay. Using the approximate correlation proposed by Stroud and Butler of undrained shear strength (Cu) = 4.5 x SPT N value, an undrained shear strength of 175kN/m2 can be assumed for an SPT N value of 39. An estimation of the angle of shearing resistance can be made based on the correlation after Peck et al (1974); for an SPT N value of 39 this equates to a angle of shearing resistance, ϕ, of 38.

Locally more competent limestone is encountered, although core recovery was typically between 60 and 80%, reflecting the presence of weaker horizons throughout the formation. Unconfined Compressive strength (UCS) test undertaken on samples of solid core indicated strengths in the range of 45 to 76MPa with a lower quartile value of 45MPa. Point load tests gave Point Load Indicies (I_{s50}), corrected for size, of 2.28 to 4.13. Previous studies by a number of authors have indicated a correlation for converting a Point Load Index to a UCS; as detailed below:

UCS = K x I_{s50} where K has been shown to range between 15 and 24 for sedimentary rocks.

Based on this correlation and using a conservative value of k of 15, this would indicate UCS values ranging between 34 to 62MPa, which correlates well with the actual UCS tests.

7.0 GEOTECHNICAL DISCUSSION

7.1 Proposed Development

It is understood that it is proposed to construct a number of new two-storey residential buildings with associated car parking and road infrastructure, the general layout of which is presented Appendix H.

Information relating to likely foundation loadings was not available at the time of reporting.

7.2 Shallow Spread Foundations

Based on the ground conditions encountered across the site, strip (traditional or narrow trench fill) or pad footings will be suitable for low- and medium-rise buildings (up to three storeys) provided they are founded within the Limestone bedrock of the Porthkerry Formation, typically encountered at depths ranging from 0.2 to 0.9m, however one trial pit encountered bedrock at 1.8m and local variations should be anticipated.

Strip or pad footings should be taken through the overlying made ground and fine grained deposits to at least 0.2m into the Limestone bedrock of the Porthkerry Formation, with a minimum founding depth of 0.85m, or as otherwise required by regulatory authorities.

For footings founded as described above, an allowable net bearing pressure of 250kPa is recommended. This will give a factor of safety of greater than 3 against ultimate bearing capacity failure. Settlement of strip footings not exceeding 0.6m width or pad footings not exceeding 1.0m square, loaded to 250kPa, is expected to be less than 20mm where the ground is predominantly clay/ or fractured limestone, and much less where competent limestone is present.

The bases of foundation excavations should be inspected by a suitably experienced engineer and any soft or otherwise unsuitable material removed and replaced with compacted granular fill or lean concrete, or the founding depth increased. Where ground conditions vary greatly in the base of foundation excavations (for instance, the transition from clay to limestone band), it would be advisable to add steel reinforcement in the area of variation to inhibit cracking and smooth out differential movement. Any hard spots (such as old foundations), should also be removed. Where foundations are required to pass through fine grained soils within the zones of influence of existing trees it is recommended that the inside faces of all foundations are protected using a compressible material, in line with the recommendations given in NHBC guidance Chapter 4.2.

7.3 Floor Slabs

Floor slabs may be ground bearing for combined dead and live loads of up to 15kPa and may be expected to settle less than 10mm provided they are on a formation either stiff fine grained deposits or limestone bedrock of the Porthkerry Formation and any layers of Topsoil have been removed. Formation levels within the fine grained soils should be proof rolled using a heavy vibrating roller and inspected by a suitably experienced engineer or inspector. Any material such as soft clay, deleterious material containing weak or degradable contaminants, or other unsuitable material, should be excavated and replaced by well-compacted granular fill.

Where proposed buildings occur within the zone of influence of existing or proposed tree planting, it is recommended that further detailed assessment of minimum founding levels be undertaken. In the unlikely event that the near surface clay soils are found to exceed 1.5m thickness and minimum founding levels of 1.5m or greater have been assessed, it would be recommended that floor slabs are suspended.

7.4 Buried concrete

The Porthkerry Formation is part of the Lower Lias, which is a known to contain 5-8% pyrite. Pyrite (FeS may be converted to sulphates and therefore total potential sulphate needs to be determined. Based on these conditions, it is recommended that for foundations the Design Sulphate Class for the site, as defined in BRE Special Digest 1, be taken as DS-3, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-2s.

7.5 Road and Pavement Design

Given the organic content of the topsoil it is assumed that this will be stripped prior to pavement construction. Based on estimates of CBR obtained using *in situ* hand held equipment and from laboratory tests results, it is recommended that a design CBR of 3% can generally be applied across the site where pavements are constructed directly onto the fine grained soils of the Porthkerry Formation.

In line with good practice, it is however recommended these design values are confirmed prior to pavement construction via *in situ* testing.

As with good construction practice it is recommended the formation level be inspected and that any areas of soft/loose deleterious strata or pockets of silt/clay are replaced with an appropriately compacted coarse

grained material. Likewise, any hard spots (such as old foundations) should also be removed to guard against reflective cracking in the pavement. Proof rolling/compaction of the formation level should be carried out prior to laying the new pavement.

For all pavement formation levels, particularly those with increasing depth, care should be taken not to cause degradation and softening due to heavy trafficking and excessive moistening. As such the formation should be protected during construction.

7.6 Temporary Works

It is considered at this stage that temporary works will comprise excavations for foundations and service runs which are likely to pass through Topsoil and into fine grained deposits and or bedrock of the Porthkerry Formation.

Trial pit excavations remained stable during investigation works however they were difficult to excavate owing to the presence of cobbles and shallow limestone bedrock. It should therefore be anticipated that similar problems will be encountered for foundation and services excavations, which may require a breaker and higher rated plant to achieve required depths.

Where man entry into excavations deeper than 1.20mbgl is required, it is recommended that excavations are either shored or that the sides of excavations are battered to a safe angle of repose.

It is not anticipated that significant dewatering will be required for foundation excavations. However, it is recommended that for any dewatering, albeit likely to be minimal be undertaken in accordance with the guidelines of CIRIA C515 Groundwater control – design and practice, 2000.

8.0 CONTAMINATION ASSESSMENT

8.1 Introduction

The UK Contaminated Land Regime allows for a tiered approach to ground contamination assessment which is designed to allow increasingly site specific site assessment. The first tier comprises a generic quantitative risk assessment (generic QRA) which forms the focus of this report. This first tier involves comparison of chemical data attained from samples taken from the site with accepted generic compliance criteria in order to identify potential constituents of concern (COCs) that may require further assessment/consideration. The generic compliance criteria are derived by means of computer modelling using input parameters reflective of typical ground conditions, chemical fate and transport properties, and typical receptors. Where COCs are identified, further investigation and/or risk assessment, such as detailed quantitative risk assessment QRA, may be undertaken.

The generic QRA present in this report is based on the chemical data attained by WYG during September 2010 and forms the basis for the risk assessment and recommendations for further investigation/assessment and remedial/risk management action presented in Section 11.0.

8.2 Generic compliance criteria (screening values)

The chemical results attained by WYG have been screened against compliance criteria for human health and controlled waters as summarised below.

Human Health Criteria:

- CIEH/LQM Tier One generic assessment criteria
- CLEA Soil Guideline Values published by DEFRA/EA (where available)
- WYG Tier 1 Screening Criteria (issue 11) derived using the derivation tool CLEA version 1.06.

Screening values for human health assessment are available for four land use scenarios; residential with plant uptake, residential without plant uptake, commercial/industrial, and allotments. As the proposed development comprises the construction of residential properties with gardens, a 'residential with plant uptake' land use scenario has been selected for the soil contamination assessment with respect to risk to human health.

Controlled Waters Criteria:

- Environmental Quality Standards (EQS)
- Dutch Intervention Values (DIVs)
- UK Drinking Water Standards for groundwater contaminants not addressed by the above.

With regard to the controlled waters assessment criteria, some compliance criteria are below the laboratory method detection limit for particular constituents. In these instances the limit of detection is considered sufficient in highlighting significant contamination and so has been defaulted to as the screening tool.

It should be noted that the above assessment criteria are intended to indicate to an assessor that concentrations above this level might present an unacceptable risk to the receptor and that further assessment, site investigation or remediation/risk management may be required. They are not intended to be used as categoric indicators of significant contamination.

8.3 Human Health Risk Assessment

Nine soil samples were taken from shallow soils underlying the site during the WYG ground investigation and were submitted for chemical laboratory testing. The chemical data have been screened against the relevant compliance criteria outlined above.

No determinants were identified to be present at levels above the relevant screening criteria for the site setting.

8.4 Asbestos

Asbestos containing materials (ACM) were not identified in any of the soil samples submitted for laboratory chemical analysis.

8.5 Controlled Waters Assessment

8.5.1 Soil derived leachate

Two soil samples were taken from shallow soils underlying the site and submitted for soil derived leachate chemical laboratory testing.

The chemical data have been screened against the relevant compliance criteria outlined in Section 8.2. The following table summarises the determinands encountered in the soil derived leachate samples which exceed their respective compliance criteria.

Table 7 Determinands identified at levels exceeding Tier 1 compliance criteria

SOIL DERIVED LEACHATE						
Determinand	No of samples	Min (mg/l)	Max (mg/l)	Screening Value (mg/l)	No of Exceedances	Locations
Copper	2	5	12	1	2	TP201 @ 0.5m, Clay TP210 @ 0.2m, Topsoil
Zinc	2	197	241	8	2	TP201 @ 0.5m, Clay TP210 @ 0.2m, Topsoil
Iron	2	1460	430	200	2	TP201 @ 0.5m, Clay TP210 @ 0.2m, Topsoil
Barium	2	430	500	100	2	TP201 @ 0.5m, Clay TP210 @ 0.2m, Topsoil
Fluoranthene	2	0.066	0.022	0.02	2	TP201 @ 0.5m, Clay TP210 @ 0.2m, Topsoil

A number of metals and fluoranthene have been identified as potential COCs within soil derived leachate from the shallow soils on site. This is discussed further in Section 11.0.

8.5.2 Groundwater

Of the monitoring installations constructed across the Picketston South West site, two installations were sampled for groundwater for chemical laboratory testing (BH202 and BH203).

The chemical data have been screened against the relevant compliance criteria outlined in Section 8.2. The following table summarises the determinants encountered in the groundwater which exceed their respective compliance criteria.

Table 8 Determinants identified at levels exceeding Tier 1 compliance criteria

GROUNDWATER						
Determinant	No of samples	Min (µg/l)	Max (µg/l)	Screening Value (µg/l)	No of Exceedances	Locations
Phenol	2	0.6	2.0	0.5	2	BH202, BH203
Aromatic hydrocarbon (C21-C25)	2	<10	23	10	1	BH202

As is shown in the table above phenol and aromatic hydrocarbon (C21-C25) have been identified as potential constituents of concern in the groundwater beneath the site.

In the case of phenol, the screening value presented in the table above is from the Drinking Water Standards, however since the site is not within a source protection zone or close to any known abstraction boreholes, the EQS screening value of 30µg/l is therefore considered to be appropriate. As a result of this, phenol is no longer considered to be a constituent of concern in terms of groundwater for the site.

8.6 Summary of COCs

The COCs identified at the site are summarised in the table below.

Table 9 COC's Identified

Soil	Soil Derived Leachate	Groundwater
NONE	Copper Zinc Iron Barium Fluoranthene	Phenol Aromatic hydrocarbon (C21-C25)

8.7 Waste

In developing the site it is likely that certain soils e.g. from foundation and service excavations might be discarded as waste. It will be the contractor's responsibility to classify the waste and to dispose of it at an offsite facility with an appropriate environmental permit for the recovery and / or deposition of the waste. The cost of classifying and disposing of waste should be allowed for by the contractor.

In some circumstances it might be possible to re-use soils on site if they are suitable chemically and geotechnical and have certainty of use (e.g. are required as part of structures of landscape that are part of the permitted development). The guidance provided in the CLA:IRE Document: Definition of Waste – A development industry code of practice should be followed.

9.0 LAND GAS RISK ASSESSMENT

9.1 Introduction

The land gas assessment presented herein has been undertaken in accordance with current guidance provided by CIRIA 665 and is based on the three round of land gas monitoring data collected by WYG during November 2010. The data was collected from a series of monitoring wells installed across the site.

9.2 Land Gas Monitoring

Monitoring installations were constructed in all of the boreholes advanced during the WYG ground investigation and targeted the shallow soils underlying the site to circa 5.5mbgl. Construction details of the monitoring installations are provided on the relevant engineering logs in Appendix B.

Three return monitoring visits were undertaken by WYG on 8th, 16th and 23rd November 2010. Methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide were monitored using a GA2000 Gas Analyser. The gas analyser was also used to record gas flows for each monitoring well. Calibration certificates for the monitoring equipment, valid during the period of monitoring, can be made available on request.

The monitoring results are provided in full in Appendix C and summarised in section 9.4 below. It should be noted that the concentrations and levels of mobile liquid and gaseous materials are likely to vary with time. The results obtained are therefore representative of conditions at the time of monitoring only.

9.3 Land gas assessment methodology

CIRIA 665 allows or a volumetric assessment of land gas data to derive a 'gas screening value' (GSV) which can be used to place the site within generic risk categories termed 'characteristic situations' which in turn determine the level of gas protection measures required (if any) for new developments. The calculation used to determine the characteristic situation for the site is as follows:

GSV (litres of gas per hour) **= maximum borehole flow rate** (litres per hour) **x maximum gas concentration** (volume/100).

The gas screening value can then be used to determine the site characteristic situation applicable in accordance with CIRIA 665 as defined in the following table.

Table 10 CIRIA 665 Gas Screening Values

Characteristic situation	Risk classification	Gas screening value (l/hr)
1	Very low risk	<0.07
2	Low risk	>0.07, <0.7
3	Moderate risk	>0.7, <3.5
4	Moderate to high risk	>3.5, <15
5	High risk	>15, <70
6	Very high risk	>70

9.4 Land gas assessment and discussion

Potential land gas sources on site:

Potential sources of land gas on limited both on-site and the adjoining sites. Made ground was not identified in the site.

Carbon dioxide:

During the return monitoring visits flow rates of <0.1l/h were recorded, therefore for a conservative assessment a flow rate of 0.1l/h is assumed. A maximum carbon dioxide concentration of 0.9% was recording during the land gas monitoring. Therefore a GSV of 0.0009l/hr is calculated. This GSV classifies the site as a characteristic situation 1 – very low risk.

Methane:

Methane was not recorded at concentrations above the limit of detection of the gas monitor. As such this classifies the site as characteristic situation 1 – very low risk.

9.5 Gas protection measures and recommendations

Based on the data attained to date and a characteristic situation of 1 (very low risk) it may be that no special gas protection measures are required (in line with guidance provided in CIRIA 665).

The primary objective of land gas monitoring is to monitor worst case conditions whereby atmospheric pressure is low (preferably <1000mbar and/or falling).The three monitoring visits undertaken to date have all been undertaken during times of low atmospheric pressure with the one monitoring round undertaken when atmospheric pressure recorded on site was less than 1000mbar. Given the minimal land gas source potential identified beneath and adjacent to the site and the results recorded to date, it is considered that the land gas monitoring data collated to date is representative of the source potential of the site.. It is therefore considered that further land gas monitoring is not required. However this is subject to the agreement of the local authority/environmental health officer.

9.5.1 Radon

As outlined in Section 2.7 the site is located in an area where full radon protection measures may be required in new dwellings. It is therefore recommended that a site specific radon report is obtained for the site which will determine the level of any protection measures required to protect against the risk from radon.

10.0 SITE CONCEPTUAL MODEL AND GROUND CONTAMINATION RISK ASSESSMENT

10.1 Overview

In general, ground contamination can occur through several causes, particularly from historical operations and activities. The contamination can result from either on site sources or from on site migration from off site sources, leading to long term liabilities under recent legislation for any site owner.

The Environment Act 1995 (Section 57) makes provisions for a risk based framework for the identification, assessment, management and redevelopment of contaminated land within the UK. The provisions of the Act came into effect in England and Wales in July 2001 and are aimed at ensuring that actions taken with respect to contaminated land are directed by a technically well founded assessment of risk.

The process of risk assessment is an evaluation of the probability of harm, and comprises the identification of sources of contamination, receptors that may be affected by the contamination and pathways by which the receptors may be harmed.

A site conceptual model for the site is presented below and is based on the site information presented in the preceding sections. The site conceptual model forms the basis for the qualitative assessment of ground contamination risks associated with the site also presented herein.

10.2 Site conceptual model

10.2.1 Sources

The primary sources of potential contamination/land gases at the site are considered to be the following:

- *Contamination in shallow soils.* Chemical testing of the shallow soils (topsoil and weathered Porthkerry Formation) and subsequent assessment has not identified any potential contaminants of concern with respect to the risks posed to human health in a residential with plant uptake (i.e private gardens) scenario.
- *Mobile contamination in shallow soils.* The Topsoil/Cohesive soils has been found to be a potential source of leachable metals and fluoranthene that may pose a risk to controlled waters should they

become mobilised (i.e. through leaching) and enter any sensitive controlled water receptors (i.e. groundwater or the on site surface water bodies).

- Groundwater: elevated concentrations of phenol and aromatic hydrocarbon C21-C25 were identified in the groundwater samples obtained from the site. It should be noted that in both the soil samples and the soil derived leachate tests, concentrations of phenol were below the laboratory levels of detection and as such it is considered unlikely that the phenol is derived from an on site source. It should also be noted that the concentrations recorded are considered to be low.

- *Land gas:* The land gas assessment presented herein indicates that the risk from land gases associated with the shallow strata underlying the site is very low. It is considered that the land gas monitoring data recorded to date is representative of site conditions therefore further monitoring is not required, however this is subject to the agreement of the EHO/Local Authority.

- *Radon:* it has been identified that the site is located in an area where radon protection measures may be required for new dwellings. This indicates that the geology below the site has the potential to produce radon gas. Without a site specific risk assessment it has been assumed that radon remains a risk associated with the site.

- *Radiation linked to surrounding land uses linked to RAF St Athan:* monitoring undertaken on site during the site investigation and of the resulting samples did not detect radiation levels above background readings.

- *UXO:* previous assessment work undertaken by Parsons Brinkerhoff has identified a low risk of UXO being present as discussed in Section 2.10. An EOD engineer from EOD Contracts Ltd provided an awareness training for personnel on sit and no suspected UXO were identified.

The primary off site sources of potential contamination at the site are considered to be the following:

- *Off site impacted Groundwater:* Hydrocarbon contamination in groundwater associated with RAF St Athan has been well documented by other consultants who have investigated the wider RAF St Athan area, however it is understood that groundwater remediation is currently ongoing.

10.2.2 Pathways

The primary pathways by which sensitive receptors may come into contact with ground contamination are considered to be the following:

- Direct dermal contact, ingestion or inhalation of contaminants within the underlying shallow made ground/soils (during redevelopment works and/or future use).
- Leaching of contaminants and horizontal or vertical migration to surface water bodies or groundwater.
- On site migration of mobile contaminants in groundwater
- The migration and accumulation of gases or vapours associated with possible ground contamination.

10.2.3 Potential receptors at risk

The following are considered to be sensitive receptors.

- Future site users
- Site construction workers during redevelopment works
- Groundwater (secondary aquifer)
- Surface water courses (Boverton Brook, 90m to the south)
- Neighbouring sites including residential properties to the west of the site.

10.3 Ground contamination risk assessment

The source, pathway, receptor linkages identified in the previous section are outlined and a qualitative risk assessment shown in the following table. The risk assessment considers the site within an area context and assesses perceived risks to identified receptors in relation to the existing site setting and the proposed development. CIRIA C552 has been used to define the risk rating presented in the Qualitative Risk Assessment matrix, the methodology for which is presented in Appendix F.

Table 11 - CIRIA C522 Qualitative Risk Assessment

This matrix is based on CIRIA C522 risk evaluation methodology, definitions for risk ratings is presented in Appendix F						
Source	**Pathway**	**Receptor**	**Consequence of risk being realised**	**Probability of risk being realised**	**Risk Classification**	**Potential risk management requirements**
Contaminants associated with general Made Ground across the site	Dermal contact Inhalation Ingestion	Future site users (residential end use)	Medium	Unlikely (based on the absence of CoC associated with the shallow soils on site).	Low risk	No risk management procedures required.
		Construction workers	Medium	Unlikely	Low risk	Although the risk from contamination is low appropriate PPE and basic hygiene procedures should be implemented during groundworks.
Mobile Contaminants associated with general Made Ground across the site	Leaching and vertical and lateral migration	Groundwater (Secondary aquifer)	Mild (reflects the designation of the underlying aquifer as Secondary)	Low (based on the generally low contaminant concentrations identified in soil derived leachate and the presence of clay within the underlying strata which would restrict migration of any leachate).	Low risk	No risk management procedures required.
		Surface water (Boverton Brook)	Medium	Unlikely (based on the generally low contaminant concentrations recorded in soil derived leachate and groundwater samples and distance to receptor)	Low risk	No risk management procedures required.

This matrix is based on CIRIA C522 risk evaluation methodology, definitions for risk ratings is presented in Appendix F						
Source	**Pathway**	**Receptor**	**Consequence of risk being realised**	**Probability of risk being realised**	**Risk Classification**	**Potential risk management requirements**
Off site contaminated groundwater	Horizontal migration onto site via groundwater	Groundwater (Secondary Aquifer)	Mild (reflects the designation of the underlying aquifer as Secondary)	Low (based on limited hydrocarbon exceedences identified in the groundwater beneath the site, and the presence of clays which would retard migration of organic compounds)	Low Risk	No risk management procedures required.
Landgas / Vapours associated with Made Ground	Migration and accumulation of vapours into enclosed spaces.	Future site users	Severe	Unlikely (based on landgas risk assessment indicating minimal landgas production)	Very Low Risk	NB the risk classification presented here reflects CIRIA 665 and not CIRIA 552. In accordance with CIRIA 665, no special gas protection measures are required. Agreement needs to be sought from the local EHO regarding the requirement for further monitoring.
	Migration through permeable materials and or preferential pathways	Off site receptors				

This matrix is based on CIRIA C522 risk evaluation methodology, definitions for risk ratings is presented in Appendix F						
Source	**Pathway**	**Receptor**	**Consequence of risk being realised**	**Probability of risk being realised**	**Risk Classification**	**Potential risk management requirements**
Radon	Migration and accumulation of vapours into enclosed spaces.	Future site users	Severe	Likely	High Risk*	Based on the information included in BRE (2007) 'Radon – Guidance on Protective Measures for new Dwellings' the site is located in an area where full radon measures may be needed in new dwellings. To mitigate the risk, it is recommended to obtain a site specific radon report for the site to determine the type and extent of radon protection measures required. ***The implementation of the recommendations in the report will reduce the risk rating for the site to low.**
Potential radioactive contaminated ground	Dermal contact Inhalation Ingestion	Future site users Construction workers	Medium	Unlikely (levels recorded during the site investigation did not indicate levels above background readings.	Low Risk	No risk management procedures required.
Potential UXO	Dermal contact Inhalation Ingestion	Future site users Construction workers	Severe	Unlikely (based on initial low risk rating and no evidence of UXO found during site investigation.	Low Risk*	*N.B The risk rating presented here reflects the initial risk rating provided by Parsons Brinkerhoff. However, recommendations should be sort from a suitably qualified EOD Engineer regarding any mitigation measures that may be required during development works.

11.0 ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

11.1 Ground Contamination Conclusions

Based on the desk study assessment and the subsequent assessment of the chemical data obtained during the intrusive ground investigation undertaken by WYG in October 2010 the overall risk rating for the site is considered to be of a low order. This risk rating takes into account the environmental setting of the site as well as the current and proposed development.

An elevated rating has been assigned to the risk associated with radon. Based on the information contained in BRE (2007) 'Radon – Guidance on Protective Measures for new Dwellings' the site is located in an area where full radon protection measures may be required. Without further site specific assessment the risk rating remains high on a protective basis. Recommendations are presented in Section 11.2.

During the assessment of chemical results obtained during the site investigation, a number of metals and fluoranthene were identified as potential constituents of concern in the soil derived leachate samples. The risk to groundwater (Secondary Aquifer) and the local surface water bodies (Boverton Brook) is considered to be low due to the lack of elevated levels of these determinants in the groundwater samples, indicating the low mobility of these determinants. It is also considered that the clay content of the underlying Porthkerry Formation will retard the migration of the contaminants.

Elevated levels of phenol and aromatic hydrocarbon C21-C25 were recorded in the groundwater samples obtained from the site. In the case of phenol, it should be noted that the screening value is obtained from the UK drinking water standards and is therefore a naturally conservative value. The environmental quality standard (EQS) for phenol is sufficiently high for phenol to no longer be considered as a constituent of concern. The elevated levels of aromatic hydrocarbon C21-C25 occur in one groundwater sample and are shown to be only slightly elevated above the relevant screening value. It is understood that an ongoing groundwater remediation scheme is in operation within the wider site of RAF St Athan associated with a fuel spillage. As such, it is considered that the exceedance does not indicate a significant risk to the local groundwater system.

The land gas monitoring carried out to date indicates that there is a very low risk to development. It is considered that the data attained to date is representative of the worst case scenario, however the local EHO may require further monitoring in line with the guidance set out in CIRIA 665 and may stipulate this as a planning condition.

With regard to potential radioactive contamination, radiation levels monitored using a scintillometer, which was used for the protection of site operatives during the WYG ground investigation works, were not recorded above background levels for the surrounding area. A low risk is therefore associated with potential radioactive contamination at the site.

11.2 Ground Contamination Recommendations

Based on the potentially high risk associated with radon it is recommended that a site specific radon assessment is undertaken for the site. This can be used to determine the relevant level of protection required for any new development, with the appropriate radon protection measure in place the risk rating can be reduced to Low.

It is recommended that a reactive strategy should be developed by the ground works Contractor to deal with any previously unidentified made ground/suspected contaminated materials. If such materials are encountered during development, as a minimum, works within the area should be suspended and a suitably experienced land quality practitioner contacted to assist in developing a suitable strategy for dealing with such materials (i.e. chemical testing and assessment or segregation and off site disposal). PPE for site personnel should be upgraded accordingly.

Whilst no asbestos containing materials (ACM) were identified during the site investigation or the subsequent laboratory chemical testing, the potential for ACMs to be present in any Made Ground subsequently identified on site remains. Should ACMs be identified in the ground during the development of the site, it is recommended that specialist advice be sought.

No UXO were encountered during the WYG ground investigation works. The original UXO/CWA DTS prepared by Parsons Brinkerhoff should be updated in light of the observations made during the WYG ground investigation and recommendations sought from a suitably qualified EOD Engineer regarding any mitigation measures that may be required during development works.

Figures

Plates

Appendices

Appendix A – Report Conditions

APPENDIX A - REPORT CONDITIONS

GROUND INVESTIGATION

This report is produced solely for the benefit of Defence Estates and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the site.

This report is based on a visual site inspection, study of readily accessible referenced historical records, the physical investigation as detailed, information supplied by those parties noted in the text, and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented in good faith without exhaustive clarification. The test results that are available can only be regarded as a limited characterisation but likely representative sample assessed against current UK and other text referenced guidelines. The impact of our assessment on other aspects of the development requires evaluation by other involved parties. The possibility of the presence of contaminants not revealed by this research, perhaps in higher concentrations, elsewhere on the site cannot be discounted.

Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categorical assurances that they will be accepted by Authorities or Funds etc. without question, as such bodies may have unpublished, often more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to WYG. In time improved practices or amended legislation may necessitate a re-assessment.

The report is necessarily limited to those aspects of land contamination specifically reported on and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents that may occur. The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contamination (past or present) exists this can only practically be better assessed following extensive on and off site intrusive investigations and monitoring.

Appendix B – Engineering Logs

Appendix C – Monitoring Data

Appendix D – Soakaway Test Results

Appendix E – Geotechnical Laboratory Results

Appendix F – Chemical Laboratory Data

Appendix G – CIRIA 552 Risk Assessment Methodology

The following tables are derived from CIRIA C552 and have been used to define the risk rating presented in the Qualitative Risk Assessment matrix in Section 11.0.

Classification of consequence

Classification	Definition
Severe	Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short term risk of pollution (note; Water Resources Act contains no scope for considering significant pollution) of sensitive water resource. Catastrophic damage to building/property. A short term risk to a particular ecosystem, or organism forming part of such ecosystem. (Note the definitions of ecological systems within the Draft Circular on Contaminated Land DETR, 2000).
Medium	Chronic damage to human health ('significant harm', as defined In DETR, 2000). Pollution of sensitive water resources (note; Water Resources Act contains no scope for considering significant pollution). A significant change in a particular ecosystem, or an organism forming part of such an ecosystem. (Note the definitions of ecological systems within the Draft Circular on Contaminated Land DETR, 2000).
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm', as defined In DETR, 2000). Damage to sensitive buildings/structures/services or the environment.
Minor	Harm, although not necessarily significant harm, which may results in a financial loss, or expenditure to resolve. Non-permanent heath effects to human health (easily prevented by means such as persona protective clothing etc). Easily repairable effects of damage to buildings, structures and services.

Classification of probability

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

Matrix of consequence against probability to gain a risk classification

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Appendix H – Proposed Development Plan