Sully Sports and Social Club
Geo-environmental Interpretative Report

St. Modwen Homes Limited

October 2014

ATKINS

Plan Design Enable

Notice

This document and its contents have been prepared and are intended solely for St. Modwen Homes Ltd's information and use in relation to the preliminary geo-environmental assessment of land at Sully Sports and Social Club. The purpose of this report is to identify preliminary ground conditions and abnormals that may inform the preparation of a masterplan for the development.

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Document history

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1. Introduction

1.1. Brief

Atkins Limited (Atkins) was commissioned by St. Modwen Homes Limited (St. Modwen) to undertake a preliminary geo-environmental and geotechnical assessment for the proposed redevelopment of Sully Sports and Social Club. The site is located to the south-east of the village of Sully in the Vale of Glamorgan on the South Wales coast, approximately 12km south of the city of Cardiff and is further described in the Atkins Desk Study report (Ref. 1).

The site is being considered for the consolidation of the current recreational facilities into the east of the site (8.0 ha) and residential development of approximately 200 homes in the west of the site (6.6ha) (Refs. 2 & 3). The site location is shown on Drawing No.5133321-ATK-001 and current layout on Drawing No.5133321-ATK-002.

1.2. Scope and Objectives

The Atkins Desk Study report (Ref. 1) concluded that the potential for significant contamination to be present within the site is low, based on the site's recorded history and site setting. However, the desk study identified a potential for localised areas of Made Ground within the site associated with former buildings, a small infilled quarry, earthworks around pitches and potential unrecorded activities. A potential off-site source of contamination has been identified, namely the infilled quarry to the west of site. Potential pathways and receptors have been identified.

In order to confirm the low risk of contamination and to identify potential geotechnical constraints on the site, Atkins recommended a ground investigation to test the Preliminary Conceptual Site Model (PCSM) presented in the desk study report (Ref 1).

The principal objectives of the investigation work were to:

- Confirm the ground conditions,
- Characterise any shallow Made Ground,
- Gain a preliminary understanding of the likely ground abnormals which may impact upon development,
- Establish a preliminary understanding of the contamination regime (soil, soil leachate and groundwater or perched water (if present)),
- Establish the soil borne gas regime to determine concentrations of carbon dioxide and methane that may be generated from Made Ground on-site or from off-site sources,
- Assess the materials encountered in terms of the suitability of materials for re-use in earthworks (if required), or for off-site disposal,
- Prepare an outline remediation strategy, if required.

1.3. Limitations

In carrying out the preliminary geo-environmental assessment, Atkins can accept no liability for the accuracy of information provided by others. Ground conditions can only be inferred between test locations and, as such, localised conditions on site are likely to vary. Furthermore, observations made at the time of investigation and during monitoring visits may be subject to variation due to atmospheric, seasonal or other effects.

Access to certain areas of the site was limited and locations were subject to the following restrictions:

- Exploratory holes were positioned within the edges of football and rugby pitches; the Sports and Social Club remains open, hence the pitches and bowling greens were not accessible.
- Avoidance of buried services including the foul sewer, overflow drain and French drains.
- Structures are present on site, which make further areas inaccessible.

This report is based on a preliminary ground investigation of the Made Ground and weathered bedrock zone; further development-specific ground investigation and risk assessment will be required.

The findings of the report have been based on the information obtained as part of the site investigation works, which were limited by depth and spatial distribution. Data between test locations have been interpolated and should not be relied upon.

This report does not advise on measures to deal with asbestos. Detailed advice should be sought from a specialist contractor, as necessary.

2. Site Setting

2.1. Site Location and Description

The site is located approximately 1km to the south-east of Sully. The village of Sully is situated in the Vale of Glamorgan on the South Wales coast. The site is irregular in shape and covers an area of approximately 14.6ha (Ref. 2). The site is accessible via South Road (B4267) on the northern boundary. The approximate Ordnance Survey National Grid Reference (OSNGR) for the centre of the site is 316250, 167730. A plan showing the site boundary and current layout is presented on Drawing No. 5133321-ATK-002.

The site lies at a level of approximately 25mAOD in the north-eastern corner, with a fall towards the south to a level of approximately 11mAOD; cliffs are present close to the site's southern boundary on the coastline.

The site comprises an area of open space used by Sully Sports and Social Club as a sports ground including three football pitches, two rugby pitches, indoor and outdoor bowling greens, an Astroturf pitch, children's play area, clubhouses and a library. The indoor bowling green and sports and social club are built at approximately 1.5m above the surrounding ground level.

Reference to the 1:25,000 OS Map (Ref. 4) indicates the Wales Coastal Path to run parallel to the southern boundary outside the site, however new fencing and signposts have recently been installed allowing access across the south of the site.

2.2. Surrounding Area

The site is situated in a predominantly residential area. Immediately south of the site is Sully Bay and Sully Island lies approximately 500m to the south-east. The village of Sully extends along the northern and western boundaries, with agricultural fields approximately 200m beyond to the north of site. The settlement of Swanbridge and the Swanbridge Caravan Park are situated adjacent to the south-east corner of site, with agricultural fields adjacent to the east.

2.3. History

A review of the site's history has been carried out through the study of Ordnance Survey mapping dating from 1879 to the present day and environmental database information contained within the Envirocheck Report (Ref. 5).

The site history is summarised as follows and should be read in conjunction with the desk study.

2.3.1. On-Site

The site was is use as agricultural land at the time of the earliest maps, dated 1879. In the north-east corner of the site, there was an old quarry which is no longer marked on the site by the 1900 map edition.

By 1943, the site had been split into five land parcels with Smither's Farm and associated buildings in the north-west corner; these had been removed from site by the 1968 map edition. By 1968, the site is labelled as a sports ground with bowling green, tennis court and clubhouse. The sports club also included a playground and swimming pool in the west between 1978 and 1988, by which time the pool is no longer marked on the map. The site remained generally the same until the 2006 maps, when a bowling clubhouse and large rectangular building are shown to the east which are still present on site today. By 2014, a library is shown in the north-west corner and two fenced pitches are shown on the centre of site.

2.3.2. Off-site

The earliest map edition (1879) shows the site was located within a rural area and is surrounded by agricultural fields. An old quarry and limekiln was located 200m to the west, Sully House and

"The Spinny" were 200m to the south-east and a pump reservoir was situated 300m to the east. A building was marked on the opposite side of the road to the north. By 1885, Sully was marked on the maps 1km to the north-west, Cog was 900m to the north and Sully Island is 500m to the south-east.

By 1900, the Taff Vale Railway was present approximately 100m to the north of site. The 1901 map shows two old quarries and two working quarries approximately 750m to the east and north-east. By 1920, the building to the north has site has been removed, a square structure has been built approximately 50m to the north-west and two houses have been built 200m to the west of site, north of the old quarry/limekiln. Two houses have been built adjacent to the railway 90m north-east and a lodge has been built 50m to the south-east of site.

The 1921 map shows additional kilns and quarries 750m to the north-east of site. Sully continues to expand with residential housing. By 1943, a housing estate has been built adjacent to the western boundary and the road adjacent to the eastern boundary is labelled as Swanbridge Road, with two houses built on the opposite side. The quarry and limes kiln to the west are no longer marked on the map. By 1968, the road to the north is labelled as South Road and residential development has continued to expand to the west, east and north-west. By 1972, the railway to the north of site is disused and large residential development to the north of site has been undertaken prior to the 1978 map edition.

2.4. Geology

2.4.1. Published Geology

The British Geological Survey (BGS) Sheet No. 263 for Cardiff (Ref. 6) indicates superficial deposits are absent within site. The solid geology underlying the site comprises the Mercia Mudstone Group (MMG) in the south of the site with the remaining area underlain by the Mercia Mudstone Group (marginal facies).

The Mercia Mudstone Group (marginal facies) are variable but *'typically consist of conglomerate and/or breccias with clasts derived from rocks lying immediately below the unconformable base of these deposits. The matrix generally consists of finer-grained rock fragments or, less commonly siltstone, sandstone or micritic limestone. Individual clasts can range up to several cubic metres in size. Fenestral and algal carbonates [interlock] with conglomerates and breccias in exposures to the South of Cardiff.'* (Ref. 7).

The Mercia Mudstone is described as mainly *'red, less commonly green-grey, mudstones and subordinate siltstones, with halite-bearing units in some basinal areas and thin beds of gypsum/anhydrite. Sandstones may also be present'* (Ref. 7).

There are four faults aligned north-south present in the south of the site. One fault is mapped immediately to the south of the coastal path and does not enter the site. One fault is shown to extend slightly beyond the coastal path and may enter the south-western boundary of the site for a short distance (this fault terminates close to the properties at the southern end of Clevedon Avenue). The remaining faults lie towards the south-eastern corner of the site and extend into the area of the pitches; one fault extends approximately half way into the site.

There are three BGS exploratory borehole records, drilled as part of the St Mary's Well Bay to Swanbridge road improvements, located 200 metres from the south-east corner of site (Ref. 7).

- ST16NE36 – Swanbridge was drilled to 9.80mbgl and encountered 0.10m of concrete over 1.30m of clay and boulders, over 3.25m of clay and sand encountering red-brown silty clay with mudstone lithorelicts (interpreted as the MMG) at 4.65m bgl.

- ST16NE35 - Swanbridge was drilled to 15.20mbgl. Tarmac was recorded overlying a concrete, gravel cobble and limestone bolder fill to 4.65m bgl, over 4.9m of sand, over 1.95m of red-brown silty clay with mudstone lithorelicts encountering a highly weathered red-brown, green-grey very weak silty mudstone with clayey and friable zones and traces of calcite at 11.50mbgl becoming moderately to slightly weathered below 14.7m bgl.

- ST16NE34 – Swanbridge was drilled to 12.0mbgl. Gravel was recorded to 0.40mbgl over 2.4m of clay and boulders over 1.2m of limestone , reddish brown silty clay and pinkish/grey limestone boulders with gravel and reddish brown silty clay, over 2.6m of brown sand. Mudstone was encountered at 6.60m bgl overlying moderately to slightly weathered green-grey limestone at 7.00m bgl, moderately weathered red-brown very weak, very silty highly jointed mudstone/siltstone at 8.50m bgl, red-brown silty fine sandstone with dolomite crystals at 9.60m bgl and weathered pink-grey and green-grey dolomite with fenestral texture at 11.0m bgl.

2.4.2. Geological Hazards

The following geological hazards are presented in the Envirocheck Report relating to potential geological hazards at the site (Ref. 5):

- Potential for collapsible ground stability hazard – very low.
- Potential for compressible ground stability hazards – no hazard.
- Potential for ground dissolution stability – very low to no hazard.
- Potential for landslide ground stability hazards – low to no hazard (moderate hazard immediately south-west of the site).
- Potential for running sand ground stability hazards – no hazard.
- Potential for shrinking or swelling clay ground stability hazards – very low to no hazard.

2.4.3. Mining and Mineral Sites

The site does not lie within an area that may be affected by coal mining however; historical quarrying of sandstone and limestone has been recorded within the surrounding area. All quarrying activity has now ceased.

2.4.4. Radon

The site is located in an intermediate probability radon area, as between 1% and 3% of homes are above the action level (Ref. 5). However, no radon protective measures are considered necessary in the construction of new structures at the site (Ref. 5).

2.5. Hydrogeology and Hydrology

There are no surface water features within the site or within 250m of the site. The closest body of marine water is Sully Bay, part of the Bristol Channel, adjacent to the site's southern boundary. The extreme southern fringes may be at risk of extreme flooding from the sea without defences. However, the zone at risk of flooding is thought to relate only to the foreshore and stops at the cliffs.

The following information is presented within the Envirocheck report (Ref. 5) relating to the site;

- The site is not located in a Source Protection Zone (SPZ).
- The Mercia Mudstone Group (marginal facies) in the north is classified as a Principal Aquifer.
- The Mercia Mudstone Group in the south is classified as a Secondary B Aquifer.
- The soils at the site are of a high leaching potential.
- There are no discharge consents recorded with 250m of site.
- There are no licensed groundwater abstractions recorded with 250m of site.
- There are no pollution incidents reported with 250m of site.

2.6. Waste

There are no historical landfill sites, registered landfill sites or waste management facilities within 500m of site (Ref. 5).

3. Preliminary Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) was developed as part of the Desk Study (Ref. 1) and is summarised below. It identified potential sources of contamination, pathways and receptors for a proposed future use as a residential-led development scheme.

3.1. Potential Contamination Sources

3.1.1. On-Site Potential Contamination Sources

The following on-site potential contamination sources have been identified;

- **Potential Made Ground** associated with areas of earthworks associated with agricultural use, demolition of farm buildings in the north-western corner, material used to build up levels around the clubhouses and the small infilled quarry in the north-east corner of site. Made Ground may contain heavy metals, ash, clinker, sulphates, polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons and asbestos. Ground-borne gases may be present from the decay of organic material in Made Ground.
- **Sulphates** within Made Ground or natural ground.

3.1.2. Off-Site Potential Contamination Sources

The following off-site potential contamination sources have been identified;

- **Infilled quarries** 200m to the west of site. The infill materials represent a potential source of migratory contamination and ground gases.

3.1.3. Plausible Contamination Pathways

Redevelopment of the site for mixed leisure / residential use is proposed. Potential contamination pathways relating to these uses include:

- Direct contact (soil, dermal contact and dust inhalation);
- Inhalation of soil/ groundwater derived volatile vapours;
- Ground gas accumulation and inhalation;
- Leaching from the unsaturated zone followed by vertical and/ or lateral migration to groundwater;
- Surface water run-off; and
- Chemical degradation of infrastructure (including water supply pipes).

3.1.4. Contamination Receptors

The potential receptors listed below may be significant:

- Current and future site users;
- Construction workers;
- Adjacent site users;
- Building, infrastructure and services (including water supply pipes); and
- Controlled waters (groundwater).

3.2. Preliminary Ground Contamination Risk Assessment

The preliminary conceptual model identified the following

Preliminary Conceptual Site Model

Potential Source	Potential Receptor	Pathway	Comment	Risk Category
On-site Made Ground	Current and future site users, construction workers.	Direct contact – inhalation (dust) and dermal contact	Earthworks have occurred on site including the demolition of buildings and use of material to raise levels for development platform. Former small quarry has been infilled. Minimal hardstanding. More sensitive future site users. Possible unrecorded activities within the site.	Moderate / Low
	Perched/ shallow groundwater	Leaching of contaminants from unsaturated soils to shallow groundwater via infiltrating waters followed by vertical migration to underlying aquifer	Contaminants may be present on site, the soils are of a high leaching potential and bedrock classified as a Principal and Secondary B Aquifer.	Low
	Nearby coastal waters (Severn Estuary)	Surface water run-off	Contaminants may be present on site with the potential to leach.	Low
Sulphates in Made Ground or natural ground	Structures	Direct contact with soil or groundwater	Sulphates in natural soils or Made Ground may create aggressive ground conditions with the potential to damage concrete.	Moderate / Low
Migration of contaminants from off-site sources (infilled quarry to the west)	Construction workers Current and future site users	Leaching and migration of contaminants. Migration of soil gas and inhalation.	Leachable contaminants within the unsaturated zone may leach by infiltrating water followed by migration to groundwater below and flow into the site. The groundwater flow direction is likely to the south towards the estuary, contaminants from the infilled quarry to the west are not likely to migrate towards site (and fill is old). Workers may come into contact with these contaminants during the construction phase.	Very Low
	On-site structures	Leaching and migration of contaminants creating aggressive ground conditions Migration of soil gas and accumulation in structures.	Leachable contaminants within the unsaturated zone may leach by infiltrating water followed by migration to groundwater below and flow into the site. The groundwater flow direction is likely to the south towards the estuary, contaminants from the infilled quarry to the west are not likely to migrate towards site. Contaminants from the railway may migrate towards site.	Very Low

4. Ground Investigation

4.1. Ground Investigation Design Rationale

The development of the PCSM (Ref. 1) highlighted possible complete pollutant pathways with respect to the proposed development. Atkins designed a preliminary ground investigation to provide broad environmental information, developing the PCSM and providing outline geotechnical information to facilitate a preliminary foundation options appraisal.

The investigation comprised the following:

- Window sample holes to a maximum 5m bgl, to investigate the near-surface ground conditions,
- Trial pits to approximately 4.5m bgl, to improve site coverage where window samples failed to achieve sufficient penetration,
- Gas and groundwater monitoring installations,
- *In situ* standard penetration tests (SPTs),
- Gas and groundwater level monitoring (4 monitoring visits following the site works),
- Geotechnical and chemical analytical laboratory testing of soils, leachate and groundwater.

The sampling strategy was primarily designed to obtain representative samples from shallow soils, including Made Ground where present. Geotechnical testing was undertaken for classification purposes and to provide preliminary data to evaluate the likely engineering properties of the Made Ground (where encountered) and natural soils.

4.2. Methodology

The ground investigation was carried out in accordance with 'Site Investigation in Construction, UK Specification for Ground Investigation, Second Edition' (Ref. 9) and was undertaken in general accordance with BS10175 Code of Practice: Investigation of Potentially Contaminated Sites (Ref. 10), BS5930 Code of practice for site investigations (Ref. 11) and Eurocode 7 (Ref. 12).

Ian Farmer Associates (IFA) was appointed as the specialist ground investigation contractor for the works, which were carried out between 21st – 22nd July 2014 with an additional day of trial pitting (due to site conditions) on the 31st Jul 2014 (Ref. 8). Engineers from both IFA and Atkins were in full time attendance during the works.

The Exploratory Hole Location Plan is presented as Drawing No. 5133321-ATK-GEO-003 (Appendix A).

4.2.1. Service Clearance

Prior to intrusive works taking place, each exploratory hole location was cleared of services using a Cable Avoidance Tool (CAT) with reference to existing site services plans obtained from utility providers.

Hand-dug inspection pits were excavated to 1.20m bgl at the location of each borehole to check for the presence of services. If there was any doubt over the proximity of a site investigation location to a potentially live service, the location was moved or cancelled.

During the ground investigation, an unrecorded outflow pipe approximately 12" in diameter and cast in concrete was identified on the cliff-face at the south of the site, the pipe appeared to extend north-south through the western half of site.

4.2.2. Window Sampling Boreholes

A total of 12 window sampling locations were intended, however WS1-WS4 refused at shallow depths and so the positions were attempted again. Location WS10 was not attempted due to time constraints incurred by the additional window sampling boreholes. In total 19 window sampling

boreholes were excavated, of which nine were terminated at shallow depths due to obstructions and are summarised below:

Abandoned / Terminated Window Sampling Locations

Hole ID	Base of Hole (m bgl)	Notes
WS1	0.75m	Dense layer of cobbles encountered at 0.75m bgl within hand dug service pit. Position moved to WS1A.
WS1A	0.20m	Dense layer of cobbles encountered at 0.20m bgl within hand dug service pit. Position moved to WS1B
WS1B	0.50m	Position terminated due to hard ground conditions within hand dug service pit.
WS2	0.70m	Concrete slab encountered at 0.70m bgl within hand dug service pit. Position moved to WS2A.
WS2A	0.72m	Concrete slab encountered at 0.72m bgl within hand dug service pit. Position moved to WS2B.
WS3	0.60m	Dense layer of cobbles encountered at 0.60m bgl within hand dug service pit. Position moved to WS3A.
WS3A	0.40m	Dense limestone layer encountered at 0.40m bgl within hand dug service pit.
WS4	0.30m	Concrete slab encountered at 0.30m bgl within hand dug service pit. Position moved to WS4A.
WS4A	0.20m	Drainage pit encountered at 0.20m bgl within hand dug service pit. Position moved to WS4B.

4.2.3. Trial Pits

A total of eleven trial pits to approximately 4.5m bgl were attempted to improve site coverage where the window samples failed to achieve sufficient penetration, A trial pit (TP10) was excavated where WS10 was not attempted.

4.2.4. Soil Sampling

Representative soil sampling was undertaken in accordance with BS5930 and Eurocode 7 (Refs. 11 and 12). Sampling was informed by visual and olfactory indicators of contamination.

Sample locations and depths were selected to ensure a suitable spread of data, both laterally and vertically.

4.2.5. *In Situ* Testing

Standard penetration tests (SPTs) were attempted within the window sampling boreholes at 1.00m intervals. A total of 11 SPTs were carried out all within the Mercia Mudstone Group to 2m bgl.

Two hand vane tests were completed during trial pitting.

The results are summarised in Section 5.

4.2.6. Geotechnical Laboratory Testing

The following geotechnical laboratory tests were undertaken:

- 10 moisture content determination;
- 10 liquid limit, plastic limit and plasticity index;
- 8 particle size distribution by wet sieving;
- 8 BRE SD1 (Ref. 13) aggressiveness to concrete.

4.2.7. Contamination Testing

4.2.7.1. Soil

Twelve soil samples were selected for contamination testing and were tested in accordance with MCERTS and UKAS accredited procedures. Seven Made Ground samples were tested for asbestos identification and three samples which tested positive for asbestos containing materials (ACMs) were quantified.

Soil Testing Suites – Testing and Testing Quantities

Testing Suite	Justification for Testing	Number of Tests
'Standard' Soil Suite pH, Total Cyanide, Total Phenols (monohydric), Speciated Polycyclic Aromatic Hydrocarbons (PAH), Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc	Testing undertaken on natural strata or reworked Made Ground samples where no anthropogenic inclusions	8
Enhanced Soil Suite pH, Total Cyanide, Total Phenols (monohydric), Speciated PAHs, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, Benzene, Toluene, Ethylbenzene, p & m-xylene, o-xylene, MTBE (Methyl Tertiary Butyl Ether), Total Petroleum Hydrocarbons-aliphatic/aromatic split (TPH-CWG).	Testing undertaken on Made Ground with anthropogenic inclusions	4
Organic Matter Content	Testing undertaken on a range of soil types across the site.	6
Asbestos Screening	Testing undertaken on Made Ground with anthropogenic inclusions	7
Asbestos Quantification	Quantification undertaken on samples where asbestos was detected at screening stage	3

4.2.7.2. Soil Leachate

Leachability testing was carried out on four soil samples and comprised the following determinands:

- pH
- Cyanide Total
- Sulphate as SO_4
- Chloride
- Ammoniacal Nitrogen
- Nitrate-Nitrogen
- Chemical Oxygen Demand
- Phenols Total
- Arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc.
- TPH-CWG
- Speciated PAH
- Calcium, magnesium, potassium, sodium
- Benzene, Toluene, Ethylbenzene, p & m-xylene, o-xylene
- MTBE (Methyl Tertiary Butyl Ether)

4.2.7.3. Groundwater

No groundwater was encountered during the groundwater monitoring visits and consequently no groundwater analysis was required.

4.3. Gas and Groundwater Monitoring

Gas and perched water monitoring installations were constructed within six of the window sampling borehole locations. The installations were constrained by the maximum depths reached by the window sampler. Construction details are summarised within the table below. The findings of the gas and perched water monitoring visits are summarised within Section 5 (Ref. 8).

Standpipe Installation Details of Exploratory Holes

Location	Response Zone (m bgl)		Response Zone (mAOD)		Stratum Monitored
	Top	Bottom	Top	Bottom	
WS2B	0.5	1.2	18.27	17.57	Mercia Mudstone Group
WS5	0.6	1.1	14.16	13.66	Mercia Mudstone Group
WS6	1.2	2.2	14.52	13.52	Mercia Mudstone Group
WS9	0.5	1.0	11.30	10.80	Mercia Mudstone Group
WS11	0.4	1.4	11.99	10.99	Mercia Mudstone Group
WS12	0.3	1.0	11.17	10.47	Mercia Mudstone Group

Gas and water monitoring visits were undertaken on four occasions between 31st July 2014 and 10th September 2014. Measurements of oxygen, methane, carbon dioxide, carbon monoxide and hydrogen sulphide together with perched water levels, barometric pressure and gas flow rates were recorded at each borehole.

Results of monitoring and sampling are presented within the IFA Factual Report (Ref. 8).

5. Ground Conditions

5.1. Topsoil

Topsoil was recorded at all locations. Topsoil directly over Made Ground was encountered at eleven locations and ranged from 0.07m (WS4A) to 0.2m (TP1) in thickness. Topsoil was recorded at the remainder of the locations over natural ground and ranged in thickness from 0.1m (TP8, WS4B, WS6 - WS9, WS11 - WS13) to 0.3m (TP6, TP9).

5.2. Made Ground

Made Ground deposits were encountered in eleven of the 30 exploratory holes.

The base of the Made Ground, where proven, was encountered at depths of between 0.3m (TP1) and 0.9mbgl. (WS2B) and ranged in thickness from between 0.1m (TP1) and 0.75m (WS2B) with an average thickness of 0.39m.

The Made Ground is predominantly described as comprising red-brown, gravelly, silty, sand and firm brown sandy, gravelly, clay. The gravel fragments comprise brick, concrete, clinker, slag, ash, plastic, glass, geotextile, limestone, sandstone and mudstone. Black gravelly, sand sized ash was recorded in WS2B. A hessian membrane over coarse, angular limestone gravel was recorded in WS4A at the base of a small slope; this was part of a French drain. All the exploratory holes were dry.

Details of visual and olfactory evidence of contamination during the investigation are presented on the exploratory hole logs and summarised in Section 5.5.

5.3. Bedrock

The weathered Mercia Mudstone Group was encountered at four locations underlying the Made Ground (TP1, TP3, TP11, WS2B), where this was penetrated, and at the remainder of the locations (19 in total) the Mercia Mudstone Group was encountered underlying the topsoil. The surface of the bedrock was encountered at depths ranging between 0.1m (WS4B, WS6-WS9, and WS11-WS13) and 0.9m (WS2B).

The Mercia Mudstone Group was recovered as red brown fully weathered (Grade IVb) or partially weathered (Grade IVa-II) weak mudstone and is generally described as very stiff, red brown, gravelly sandy silty clay. Gravel is fine to coarse, angular to sub-angular mudstone, siltstone and limestone. In TP1, TP2 and TP3 mudstone and limestone cobbles (>0.20m diameter) were encountered. In TP9 and TP7, horizontal bedding was recorded in the mudstone recovered.

Gypsum veins were recorded at 0.30m in WS13, 0.15m in TP2, 0.20m in TP7 and 1.30m in TP11.

5.4. Summary of Ground Conditions

Strata	Range in Depth to Top where present; mbgl	Range in Depth to Base where present; mbgl	Range in Thickness Where Penetrated; m (Average)
Topsoil	0.00	0.07-0.30	0.07-0.30 (0.15)
Made Ground	0.10-0.20	0.30-0.90	0.10-0.75 (0.39)
Mercia Mudstone Group	0.10-0.90	Not Proven	Not Proven

5.5. Indications of Potential Contamination (Visual and Olfactory Observations)

Visual and olfactory observations of contamination during the recent site investigation were limited to slag, ash and clinker as summarised in the table below.

Visual and Olfactory Indicators of Contamination

Hole ID	Depth (m bgl)	Comments
WS2	0.40-0.70	Coal and clinker
WS2A	0.40-0.72	Clinker
WS2B	0.15-0.40	Ash, clinker & slag
WS2B	0.40-0.50	Clinker & slag
WS3	0.10-0.60	Clinker
TP1	0.20-0.30	Ash
TP3	0.10-0.60	Ash
TP11	0.18-0.40	Clinker

5.6. Groundwater

There was no groundwater encountered during the ground investigation or during the monitoring visits.

5.7. Soil Borne Gas

The results of the gas monitoring are summarised in the IFA factual report (Ref. 8). The four monitoring rounds are summarised below;

Gas Monitoring Summary

Hole ID	O_2 (% v/v)	CO_2 (% v/v)	CH_4 (% v/v)	H_2S (ppm)	CO (ppm)	Gas Flow Rate (l/hr)	Water Depth (m bgl)
	Steady (Min)	High (Max)	High (Max)	Peak (Max)	Peak (Max)	Peak (Max)	(Max)
WS2	15.3	3.9	0.1	0	0	0.1	DRY
WS5	19.9	1.2	0.1	0	0	0.0	DRY
WS6	20.2	1.5	0.4	0	1	0.0	DRY
WS9	18.3	2.8	0.0	0	7	0.0	DRY
WS11	17.6	1.9	14.9*	0	0	0.2	DRY
WS12	19.1	1.3	0.7	0	1	0.1	DRY
Max	15.3	3.9	14.9	0	7	0.2	DRY
Grand Average	19.5	1.0	0.7	0	0	0	DRY

* Result queried and confirmed to be correct, however it is not considered representative of typical gas concentrations at this location.

6. Geotechnical Laboratory and Field Test Data

6.1. General

Geotechnical testing data from the preliminary ground investigation is presented within the Factual Report (Ref. 8) and is summarised below.

6.2. Made Ground

The general geotechnical properties determined for the Made Ground are summarised below.

Made Ground – Geotechnical Testing

	Number of Tests	Range	Average	Assessment
Natural Moisture Content (%)	2	14-25	19.5	-
Liquid Limit (%)	2	41-51	46	Modified Plasticity Index 12% - 19% Low Volume Change Potential
Plastic Limit (%)	2	22-39	30.5	
Plasticity Index (%)	2	12-19	15.5	
% passing 425µm sieve	2	100	100	

One particle size distribution test was undertaken on a sample of the Made Ground. The finding indicates the Made Ground is cohesive and can generally be described as a gravelly, sandy, silt/clay.

6.3. Bedrock - Mercia Mudstone Group

The general geotechnical properties determined for the Mercia Mudstone Group are summarised below.

Mercia Mudstone Group and Mercia Mudstone Facies – Geotechnical Testing

	Number of Tests	Range	Average	Assessment
SPT N Values	11*	31->50	48*	Very Stiff to Hard (Cohesive)
Natural Moisture Content (%)	8	9.9-32	16	
Liquid Limit (%)	8	26-49	39	Modified Plasticity Index 4% - 22% Low to Medium Volume Change Potential
Plastic Limit (%)	8	15-27	23	
Plasticity Index (%)	8	5-22	16	
% passing 425µm sieve	8	22-100	76	

*10 SPT results from depths between 0.3m and 2mbgl refused on very dense/ hard ground. Results included in the average as N=50.

Eleven particle size distribution tests were undertaken within the Mercia Mudstone Group. The

findings generally indicate that the Mercia Mudstone Group comprises a brown gravelly sandy silt/clay and the Mercia Mudstone Group Facies a silty clayey gravel.

6.4. Sulphate Testing

Soil testing conducted in accordance with BRE Special Digest 1 (Ref. 13) gave the following results.

BRE Concrete Classification Testing Results

Strata	Details	Range	Concrete Class
Mercia Mudstone Group	Number of Tests	8	DS1 – AC1
	Water Soluble Sulphate (mg/l)	12 – 46	
	Mean of highest two results	36	
	pH	7.1 – 9.0	
	Mean of lowest 20% of pH results	8	

Chemical testing of soils for concrete classification indicates that a preliminary concrete classification for concrete extending into the bedrock and not in contact with Made Ground is DS1 and Aggressive Chemical Environment for Concrete (ACEC) class of AC1 should be suitable for buried concrete within the bedrock and could be used for preliminary design purposes for structures within the site.

7. Contamination Assessment

7.1. General

The following presents a summary of the chemical analysis and a preliminary assessment of the results based on the proposals for the site Generic Assessment Criteria.

7.1.1. Human Health

Detailed guidance on human health risk assessment is available within a number of documents, published by the Environment Agency and Defra, which comprise the Contaminated Land Exposure Assessment (CLEA), Model Procedures for the Management of Land Contamination (CLR11) and the National Planning Policy Framework (Refs. 14 and 15).

A Tier 2 Generic Quantitative Risk Assessment (GQRA) has been carried out for the potential human health pollutant linkages, based on the screening of soil contamination data against relevant Generic Assessment Criteria (GAC) where these are available, including:

- **Environment Agency Soil Guideline Values** - the Environment Agency has published a number of GACs for human health known as Soil Guideline Values (SGVs). These are for the CLEA standard land uses; residential housing with gardens where food may be grown; allotments; and commercial land uses.
- **Atkins' Soil Screening Values** - to supplement the SGVs, Atkins has derived GACs following the CLEA guidance that are referred to as Soil Screening Values (SSVs). SSVs are available for the CLEA standard land uses for a wide range of typical brownfield contaminants. SSVs have also been derived for land uses not given in the CLEA Model but which have been developed by Atkins following the methodologies given in the CLEA guidance. Two sets of GACs have been developed, for a sand soil with 1% Soil Organic Matter (SOM) and a sandy loam with 6% SOM.

Further screening values have recently been released by Defra (Ref. 16) in the form of Category 4 Screening Levels (C4SLs). Defra identifies that there is 'a potential role for Category 4 Screening Levels (C4SLs) in providing a simple test for deciding that land is suitable for use and definitely not contaminated land'. C4SLs are, therefore, considered within this report for contaminants for which screening levels have so far been established.

The site is being considered for the relocation and consolidation of the current recreational facilities and residential development of approximately 200 homes (Ref. 2). Initially the GAC for a residential with the consumption of homegrown produce (based on SGVs and Atkins' SSVs) have been used for the site.

A Soil Organic Matter (SOM) content of 1% (sandy soil) has been used for this assessment, as this is the most conservative set of SSVs and closest to the Soil Organic Matter encountered on site (average 3%).

It should be noted that the GACs are liable to change as new policy and technical guidance, including toxicological data, are published by the Environment Agency and other authoritative sources. Further to this, a Detailed Quantitative Risk Assessment (DQRA) may be required by the developer to review the level of conservatism in the screening values, depending upon the outcome of the generic data screening exercise at detailed design stage.

7.2. Soil Contamination Assessment

The table below lists the samples which have been tested. Samples for which soil leachate testing was undertaken are marked (*). The analysed data is presented in Appendix B.

Soil Samples Tested for Presence of Contamination.

Exploratory Hole	Stratum	Depth (m)
WS3	Made Ground	0.35
WS6	Mercia Mudstone Group	0.50
WS12	Mercia Mudstone Group	0.40
TP1	Made Ground	0.25
TP1	Mercia Mudstone Group	0.60
TP3	Made Ground	0.15
TP3	Mercia Mudstone Group	0.90
TP4	Mercia Mudstone Group	1.50
TP5	Topsoil	0.10
TP9	Topsoil	0.05
TP11	Made Ground	0.30
TP11	Mercia Mudstone Group	0.50

7.3. Risk Assessment

7.3.1. Human Health

Seven samples from the Made Ground were screened for the presence of asbestos. Amosite was confirmed in two of the soil samples (TP1 and TP3) and chrysotile was detected in one of the samples tested (WS3). These exploratory holes are located in the north-west of the site, in an area previously occupied by farm buildings. The three samples that tested positive for asbestos were subjected to quantification testing and concentrations were found to be below the detection limit of detection (<0.001%). Therefore it can be concluded that asbestos is present within the Made Ground but it has not been identified at significant concentrations. The implications of these results should be discussed with a specialist asbestos consultant.

Twelve soil samples were analysed for the presence of contaminants, as detailed in Section 4.2.7. The majority of the samples fall below the GAC for residential with plant uptake end use.

Concentrations of benzo(a)pyrene marginally exceeded the screening value in three samples of the Made Ground (TP1 at 0.3m, TP3 at 0.2m and WS3 at 0.4m), with a maximum concentration of 3.0mg/kg compared to a screening value of 0.818mg/kg. The result falls below the DEFRA Category 4 Screening Levels (C4SL) for the proposed end-use (5mg/kg) and therefore are not considered to represent a significant risk to future site end-users (Ref. 17). Reference to the exploratory hole logs reveals the presence of ash and clinker within these samples. The exceedances were recorded within the exploratory holes in the north-west corner of the site, coinciding with the area where asbestos was also identified. Given the absence of elevated PAHs recorded in remaining samples tested, it considered likely the contamination is localised and the risks to end-users are considered to be low.

The material in this area are considered unsuitable for use in garden areas or soft landscaping, due to the anthropogenic inclusions. As a result, the development will require placement of subsoil and topsoil as a growing medium which will introduce a barrier without a requirement for formal remediation.

The assessment has indicated that significant contamination has not been identified at the site with respect to the proposed end-use; however further assessment will be required as part of the design process, paying particular attention to the potential re-use of material in the north-west of the site (which will require advice from a specialist asbestos consultant).

7.4. Groundwater Assessment

7.4.1. Soil Leachate

The soil leachability test data when compared to DWS (Ref. 18) and EQS standards (Ref. 19) for heavy metals indicated no exceedances in the four samples tested. The concentration of lead in one sample (0.4m in WS3) was found to equal the Drinking Water Standard (10µg/l).

7.4.2. Groundwater and Surface Water Samples

No groundwater was encountered during the ground investigation for sampling and analysis.

7.5. Soil Borne Gas Assessment

The results of the gas monitoring were assessed using the classification system presented within CIRIA C665 (Ref. 20) and NHBC guidance (Ref. 21). The classification system uses gas concentrations and recorded flow rates for methane and carbon dioxide to determine a gas screening value (GSV). The GSV is calculated by multiplying the maximum recorded flow rate (l/hr) against the maximum recorded gas concentration (%) determining a value reflecting the worst case scenario. The GSV is used in turn to determine a characteristic situation for the site.

Based on the data available, the highest gas concentration recorded during the monitoring visits was 3.9% v/v for carbon dioxide (WS2 21/08/2014) and maximum flow of 0.2l/hr are used giving a GSV of 0.0078l/hr for carbon dioxide. This places the site within Characteristic Situation 1 (CS1) or green, which requires no gas protection.

The highest concentration of methane recorded was 14.9%; however, this value is anomalous because it was only recorded once in WS11 and the following monitoring visits recorded no methane at this location. Furthermore, the elevated methane concentration did not coincide with depleted oxygen, as is usually the case. As a result, this result has been discounted from the assessment. Methane elsewhere was detected up to 0.7% on the first visit but no methane was recorded on subsequent visits in any borehole. The apparent methane results may be due to volatiles being present in the standpipes following their construction and interfering with the infra-red sensor in the gas analyser, although it is unclear what the source of volatiles may have been.

Further gas monitoring should be undertaken as part of the development specific ground investigation and the gas regime should be reassessed as part of the design process.

8. Refined Conceptual Site Model

8.1. Human Health Conceptual Site Model

Made Ground is present on site, with isolated GAC exceedances of benzo(a)pyrene; however these are below C4SL. Asbestos has been identified within the Made Ground, although this was below the limit of detection for quantification testing. There is the possibility of further asbestos and contamination being present on site, however this has so far been limited to Made Ground in the north-western corner of the site; with careful management, this should present a low risk to future site users.

8.2. Hydrogeological Conceptual Site Model

No groundwater was encountered on site, so cannot be assessed fully. A single leachate sample had lead at an equal level to the lead assessment criteria. As significant contamination has not been identified on site, shallow groundwater is absent and the soil is reasonably cohesive, it is considered the risk to groundwater is very low.

8.3. Property Risk Assessment

8.3.1. Services and Foundations

Assessment of sulphate and pH, along with the absence of significant contamination, indicates that no specific measures will be required to protect foundations or services. However, this should be further assessed as part of the development-specific ground investigation and/or during excavation of soils at the site as part of the development.

8.3.2. Soil Borne Gas

The site can generally being classified as CS1 or green, which requires no levels of gas protection.

8.4. Summary of Pollutant Linkages

A summary of the Revised CSM is presented in the table below.

Revised Conceptual Site Model

Potential Source	Potential Receptor	Pathway	Risk Category
On-site Made Ground (benzo(a)pyrene and asbestos)	Current and future site users, construction workers.	Direct contact – inhalation (dust) and dermal contact	Low-Moderate
	Perched/ shallow groundwater	Leaching of contaminants from unsaturated soils to shallow groundwater via infiltrating waters followed by vertical migration to underlying aquifer	Very Low
	Nearby coastal waters (Severn Estuary)	Surface water run-off	Negligible
Sulphates in Made Ground or natural ground	Structures	Direct contact with soil or groundwater	Very Low

Potential Source	Potential Receptor	Pathway	Risk Category
Migration of contaminants from off-site sources (infilled quarry to the west)	Construction workers Current and future site users	Leaching and migration of contaminants. Migration of soil gas and inhalation.	Negligible
	On-site structures	Leaching and migration of contaminants creating aggressive ground conditions Migration of soil gas and accumulation in structures.	Negligible

9. Engineering Assessment

9.1. Proposed Development

The site is being assessed for the relocation and consolidation of the current recreational facilities into new pitches and facilities within the east of the site (8.0 ha) and residential development of approximately 200 homes in the west of the site (6.6ha). A preliminary masterplan is shown in Drawing 13162/3007 (Ref. 3).

Current ground levels at the site range from approximately 25mAOD in the north-eastern corner, with a fall towards the south to a level of approximately 11mAOD; cliffs are present close to the site's southern boundary on the coastline.

9.2. Engineering Ground Abnormals / Development Constraints

Based on the available data, the following ground (geotechnical engineering) abnormals and development constraints have been identified:

- Made Ground is present in areas of historical buildings (Smither's Farm) and earthworks associated with agricultural activity. Made Ground up to 0.9m thick was recorded in the north of the site, where it overlies the bedrock. Made Ground is considered to be an unsuitable founding medium unless subject to ground improvement.
- Demolition arisings (brick and concrete) have been identified within the Made Ground in the areas of former buildings / structures in the north-west of the site (containing low concentrations of asbestos).
- Drainage infrastructure is present to the south of the bowling arena, comprising hessian lined angular to sub-angular gravel.
- French drains are present in the west of the site extending north-south towards the coastline however the exact locations of which have not been recorded.
- Volume change potential is variable in different materials on site. The Made Ground has low volume change potential and the Mercia Mudstone Group has low to medium volume change potential. The presence of cohesive soils with medium volume change potential locally will need to be considered when assessing depths of foundations, particularly in areas where trees are present (including areas where trees are removed or future planting).
- Groundwater was not encountered within the installations (up to 2.2m bgl).
- One unrecorded service was encountered during the ground investigation site operations, associated with the outfall on the cliff to the south of the site; it remains unclear who owns this pipe or what its precise location is through the site. Furthermore, the foul sewers running approximately east-west through the site will need to be considered as part of the master planning exercise.

9.3. Existing Structures and Services

The library and clubhouse buildings remain on site; where necessary, these will need to be demolished and the foundations removed. Hardstanding areas and buried structures (such as potential remnants of the farm buildings and concrete slabs recorded within WS2 and WS2A) will also require removal, at least within the zone of influence of future foundations. Excavated areas and voids will need to be backfilled to an engineering specification.

Should any trees be removed in areas of future buildings, the root zone will need to be excavated and voids backfilled in accordance with an engineering specification with site won materials, in order to reduce the risk from heave.

9.4. Contamination

The results of the preliminary investigation have generally revealed a low risk of contamination within the site. However, this should be confirmed by further development-specific ground investigation and visual inspection of material as it is reworked.

Localised contamination was identified in the north-west of the site, where the farm buildings were previously located. Exceedances for benzo(a)pyrene were identified in Made Ground at three locations within the zone of human interaction (0.6m) although the results fall below the C4SL for the proposed end-use. Three samples tested positive for asbestos, however the percentage of asbestos in each sample was below the detection limit (0.001%). It should be noted that presence of asbestos within the Made Ground elsewhere within the site cannot be discounted.

As a result, no formal remediation is presently considered necessary with respect to contamination at the site; however, this should be reviewed once final levels are known and following development-specific ground investigation and a Remediation Strategy developed, if required. Risks associated with asbestos will need to be assessed by a specialist consultant.

9.5. Preliminary Foundation Assessment

Parts of the site are underlain by Made Ground extending up to 0.9m bgl.

The Made Ground deposits are considered an unsuitable founding stratum due to the variable nature of the deposits and risks associated with low and variable bearing capacity and potential for high differential settlement. Foundations should be extended through the soft materials into the bedrock, comprising very weak to weak mudstone. Where the mudstone is significantly weathered, excavations should be locally deepened.

The Mercia Mudstone should be suitable for foundations for residential development of two to three storeys, subject to confirmatory testing.

9.6. Excavations for Development and Services

Based upon the works undertaken on the site, excavations for foundations and services should be possible in the Made Ground and natural soils using normal hydraulic plant. Obstructions to normal plant will arise through hardstanding, underground structures, foundations and services.

It should be noted that many of the window sampling boreholes terminated at shallow depths owing to obstructions in the Made Ground, however the machine excavated trial pits reached natural strata without significant resistance, suggesting that shallow excavations for foundations and services will not be significantly impeded. Deeper excavations into the mudstone for services may require hard digging.

9.7. Earthworks

The site lies at a level of approximately 25mAOD in the north-eastern corner, with a fall towards the south to a level of approximately 11mAOD; cliffs are present close to the site's southern boundary on the coastline. However, gradients are not typically excessive and the site is large enough to accommodate changes in level within development plots.

The Made Ground was found to have low plasticity and the Mercia Mudstone Group low to medium plasticity; arisings excavated will be suitable for reuse as an engineering material providing its moisture content can be managed; however, should this be difficult to achieve, it may be suitable for use in landscape areas or non-structural fill.

Topsoil should be re-used in the landscaping areas as it is unsuitable for reuse as engineering fill. Made Ground is likely to be geotechnically suitable for use if it is suitably engineered; alternatively it will also be suitable for re-use on site as a non-structural fill.

Where material is deemed geotechnically suitable for re-use through excavation and recompaction, it will require careful selection and control of moisture content and subject to meeting contamination

re-use criteria (chemical testing to date suggests the majority of material on site will be suitable for re-use but this will need to be confirmed). Suitable material would also require protection during periods of inclement weather. It may be possible to use soft materials that have not been dried in areas of soft landscaping.

Re-use of excavated materials within the site will require materials management in accordance with the CL:AIRE Voluntary Code of Practice (CoP) (Ref. 22), as discussed in Section 9.11. The Made Ground in the north-west of the site was found to contain asbestos (at low concentrations) and marginal exceedances of benzo(a)pyrene; re-use of this material should be subject to risk assessment and discussed with the regulators.

Material that is re-used on the site should be placed in accordance with an appropriate Engineering Specification, such as the Highways Agency Specification for Highways Works (HASHW, Ref. 23), with appropriate site specific criteria. If used in earthworks to support structural development, specific testing requirements, such as plate bearing load tests, will be required.

9.8. Pavements and Hardstanding

Assuming only limited earthworks are required, the proposed pavement and road formation levels and sub-grade materials will vary and are likely to comprise Made Ground and weathered bedrock.

The Made Ground will be highly variable and likely to require some general improvement; where it is excavated and recompacted, this will form part of the earthworks. The general competence of the exposed formation outside areas of formal earthworks should be confirmed by proof rolling, as required for a pavement layer 200mm thick, and areas of locally inferior performance identified and either soft areas removed or pavement design CBR adjusted as appropriate.

For the long term performance of the pavement, design CBR should comply with the requirements in Highways Agency or Local Authority guidance for equilibrium CBR which is based on a range of conditions including soil classification, pavement thickness, water table and construction conditions.

The condition of the formation during construction should be confirmed by testing at formation level by in situ CBRs, subject to particle size constraints or plate bearing load tests interpreted to provide the CBR value.

9.9. Trees – Shrinking and Swelling Clays

The soils underlying the site generally have a low to medium volume change potential. There are a number of semi-mature and mature trees on the site of various species.

Consideration will need to be given to the presence of existing trees that are removed, retained trees and the planting of future trees when considering the depths of the foundations. Foundation design should be undertaken in accordance with the NHBC guidance (Ref. 24) appropriate to the volume change potential of the soils at any particular location. In areas where trees are removed, consideration should be given to the potential for heave as potentially desiccated materials are rehydrated, with material excavated and recompacted as necessary in order to reduce the risk from heave.

The Arboricultural Report should be reviewed in order to determine the height and species of the trees present (with surveys updated as required at the time of development). Further development specific investigation and geotechnical testing will need to be undertaken by the developer in order to determine the degree and depth of desiccation around trees for detailed foundation design.

9.10. Drainage

The underlying natural geology is generally cohesive. These materials are not considered likely to be sufficiently permeable to allow soakaways. Soakaways should also be avoided in proximity to the cliffs, where water may reduce stability.

9.11. Waste Management

9.11.1. Management of Soils

It is anticipated that materials excavated on site will be suitable for re-use as a part of the proposed development subject to careful handling and treatment.

Excavations will be undertaken on the site for the foundations of the proposed buildings and the roads through the site. It is anticipated that excavated materials can be re-used within the site.

Excavated Made Ground materials that are being re-used will need to be tested and assessed in terms of risks to human health, although testing to date indicates that materials will be chemically suitable. Where suitable, this will need to be stored and covered until required for re-use. Naturally occurring materials that are excavated and free from cross-contamination may be considered chemically suitable without further chemical testing. All materials will need to be tested to ensure they are geotechnically suitable.

It is recommended that the developer considers site levels and potential opportunities to use site-won material (or limit its generation) at master-planning stage.

9.11.2. Waste Management

The re-use of on-site excavated soils should be undertaken under the latest version of the CL:AIRE Definition of Waste, Development Industry Code of Practice (currently version 2, Ref. 22). Under the CoP, materials excavated on-site are not deemed to be waste if they are suitable for re-use (chemically and geotechnically) at specified locations or generally within the site. A ‘Qualified Person’, as defined under the CoP, will review a Materials Management Plan, Risk Assessments and Remediation Strategy/Design Statement, together with documentation relating to Planning and Regulatory issues, and will sign a Declaration which is forwarded to the Environment Agency confirming compliance with the CoP.

Any disposal of material off-site will require appropriate pre-classification and pre-treatment to minimise the waste volume. It is recommended to maximise the re-use of materials on-site, where possible on grounds of both cost and sustainability. Early consideration of the re-use of material at planning stage is recommended, in order to maximise opportunities.

10. References

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24. National House Building Council. NHBC Standards Chapter 4.2, Building Near Trees, 2008.

Appendices

Appendix A. Drawings

Drawing No. 5133321-ATK-001 – Site Plan

Drawing No. 5133321-ATK-SLY-XX-DR-C-002 – Site Boundary

Drawing No. 5133321-ATK-SLY-XX-M2-C-003 – Exploratory Hole Location Plan

Arturus Drawing No. (03)SK014 – Proposed Site Plan

Pad Design Drawing No. 13162/3007 – Concept Master Plan

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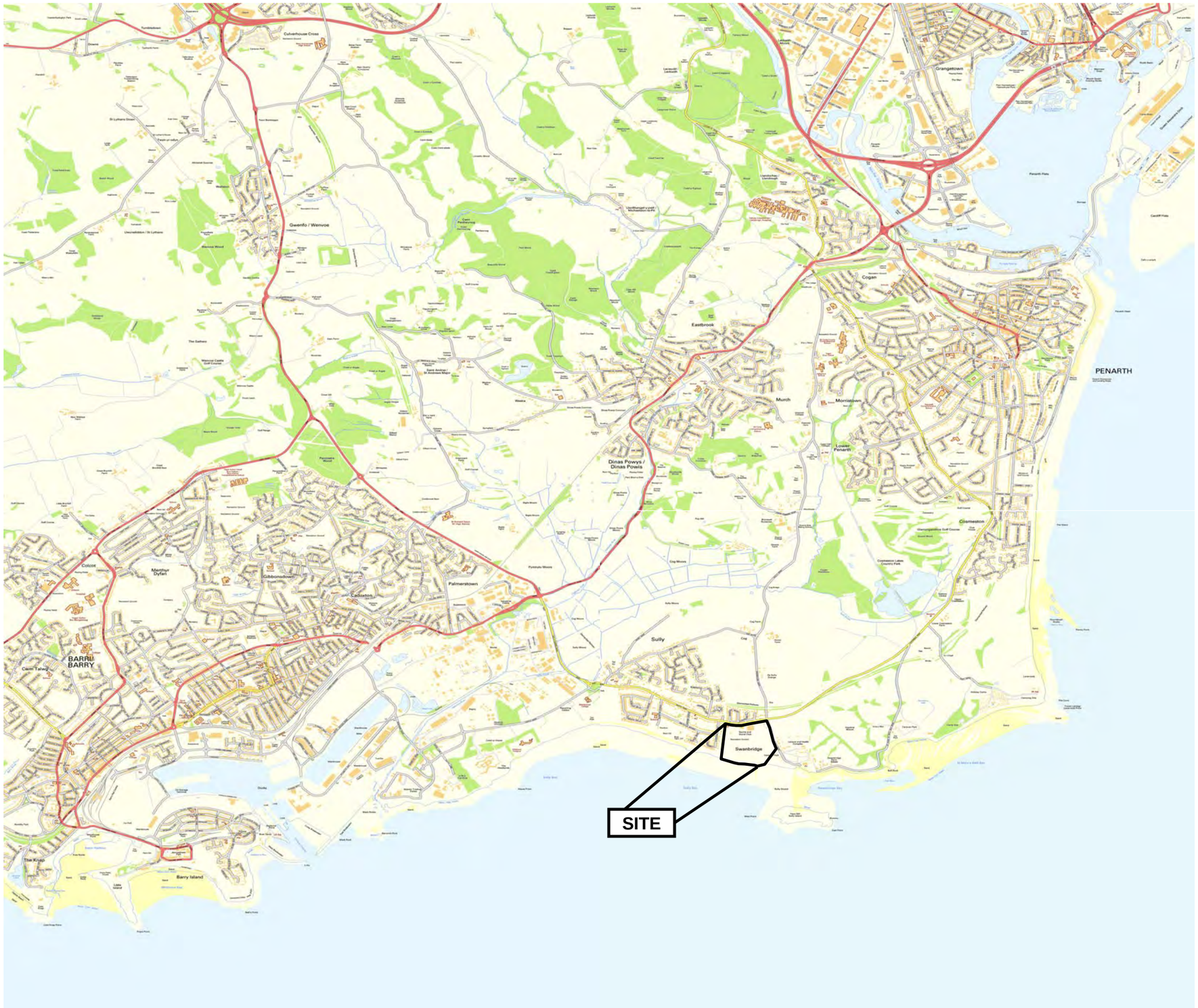
5133321-ATK-001



Key

Site Boundary

N

REVISIONS	Drawn by	Checked by	Date

PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

Atkins

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The Axis 10 Holliday Street
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CLIENT

St. Modwen Homes Limited

PROJECT

Phase 1 Desk Study Report
Sully Sports and Social Club

DRAWING TITLE

5133321-ATK-001 Site Location Plan

SCALES	DRAWN	CHECKED	CO-ORD CHECK
NTS	SH		-
	DATE	DATE	DATE
	29/08/2014		-

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SHEET	PLOT DATE
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DRAWING NO

Figure 1

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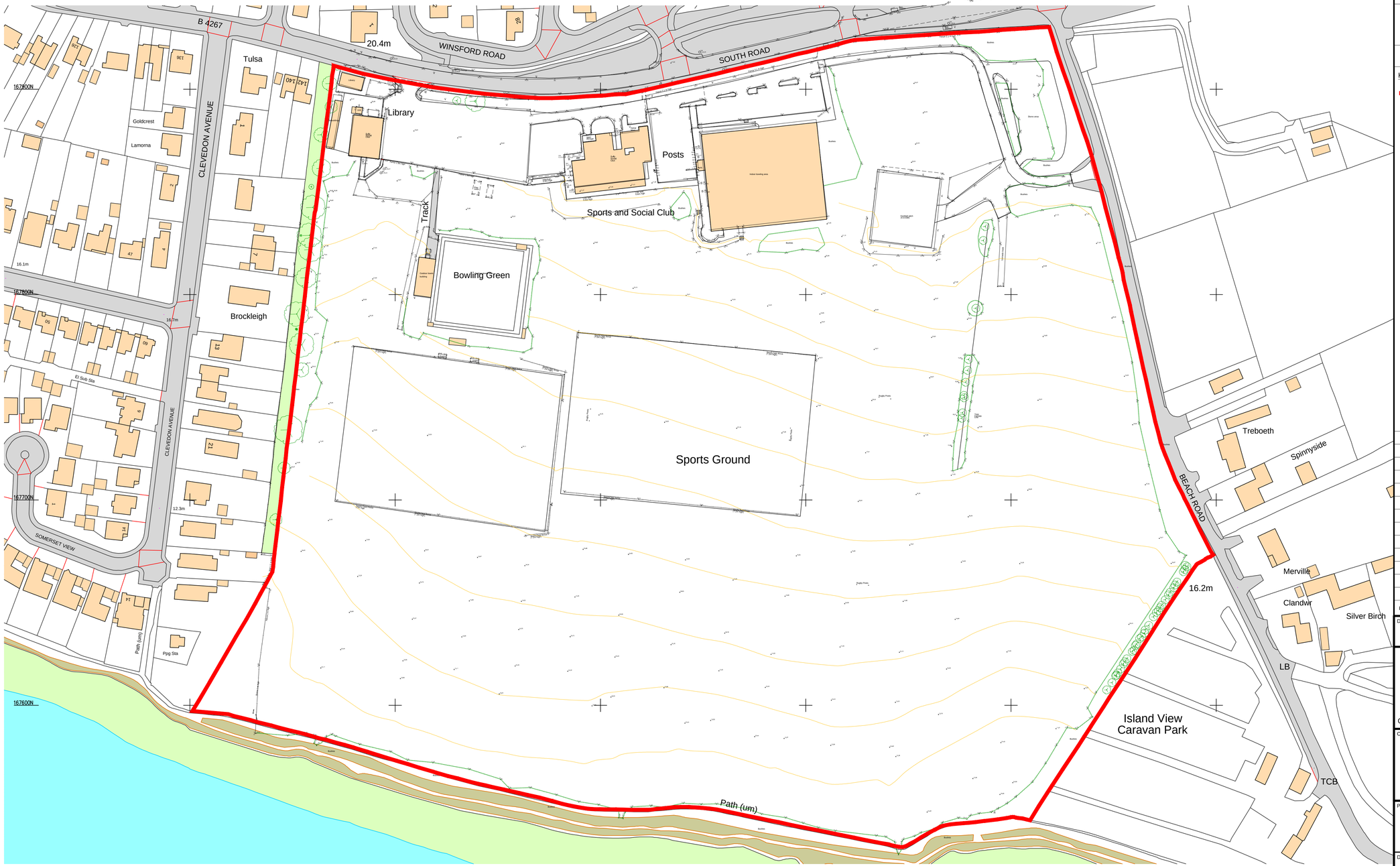

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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:

CONSTRUCTION

MAINTENANCE/CLEANING

DECOMMISSIONING/DEMOLITION

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Key:

SITE BOUNDARY

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

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Client: ST.MODWEN

Project Title: SULLY SPORTS & SOCIAL CLUB

Drawing Title: SITE BOUNDARY PLAN

Scale	Designed	Drawn	Checked	Authorised
1:1000	SH	JSD	SH	--
Original Size	Date	Date	Date	Date
A1	29/08/14	29/08/14	29/08/14	-

Drawing Number: 5133321-ATK-SLY-XX-DR-C-002

Revision: P01

DO NOT SCALE

Millimetres 100 0 10

B 4267

WINSFORD ROAD

SOUTH ROAD

CLEVEDON AVENUE

BEACH ROAD

Tulsa

Brockleigh

Library

Posts

Sports and Social Club

Track

Bowling Green

Sports Ground

Island View Caravan Park

Path (um)

20.4m

16.7m

12.3m

16.2m

Ppg Sta

WS1 WS1A WS2A WS2B WS2 WS3 WS3A WS4 WS4A WS4B WS5 WS6 WS7 WS8 WS9 WS10 WS11 WS12 WS13

TP01 TP02 TP03 TP04 TP05 TP06 TP07 TP08 TP09 TP10 TP11

N

KEY:

WS WINDOW SAMPLE

TP TRIAL PIT

Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: FOR INFORMATION

Suitability: S0

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Client: ST.MODWEN

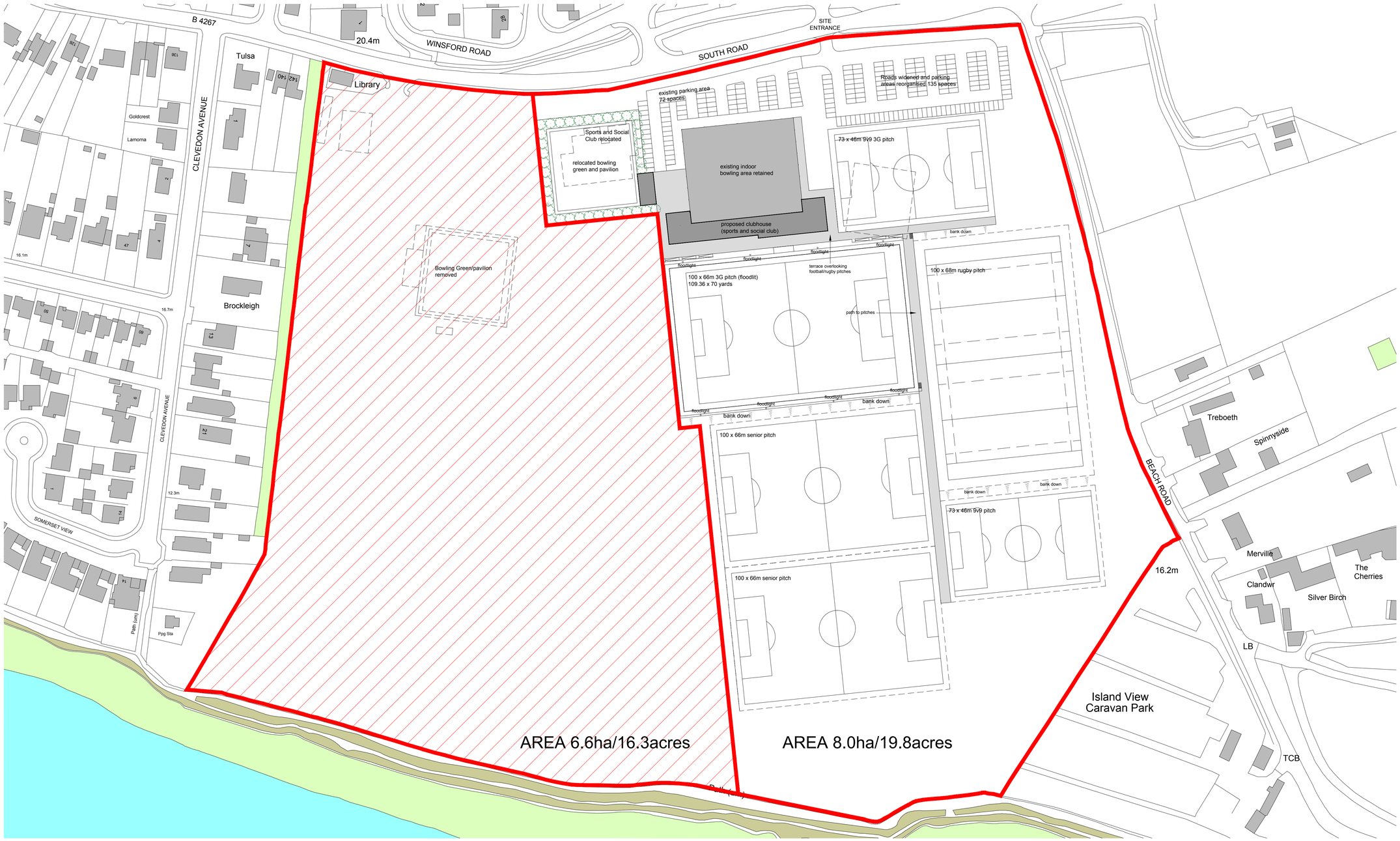
Project Title: SULLY SPORTS AND SOCIAL CLUB

Drawing Title: TRIAL PIT AND BOREHOLE LOCATION PLAN

Scale	Designed	Drawn	Checked	Authorised
SCALE	SH	RJ	SH	--
Original Size	**Date**	**Date**	**Date**	**Date**
A1	02/09/14	02/09/14	02/09/14	--/--/--

Drawing Number: 5133321-ATK-SLY-XX-M2-C-003

Revision: P01



Revisions

Job Title
Sully Sports Ground

Client
St Modwen

Drawing
Proposed Site Plan

Project No.	Drawing No.	Rev	Scale
3773	**(03)SK014**		**1:1000 @ A1**

Date **21.02.14** Drawn / Checked **gm/rg** Status **preliminary**

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ARTURUS ARCHITECTS

Access

1: Vehicular access from South Road to residential area re-using existing access with long range view to coast
2: Pedestrian/cycle connection and potential emergency access
3: Vehicular access to Sully Sports and Leisure Club car parking
4: Existing bus stops on South Road
5: Public Right of Way access from coastal footpath alongside housing to west
6: Public Right of Way access from Beach Road to coastal footpath alongside caravan park
7: Potential for vehicular loop within residential area with highway deflections to help create a low speed environment

Development

8: Sully Sports and Leisure Clubhouse, incorporating retained indoor bowls building and extension to the south
9: Medium density housing development to create body of the residential area
10: Low density housing development along western and southern boundaries
11: Housing fronting sports ground with views to eastern woodland
12: Low density housing along southern edge to reduce visual impact

Landscape

13: New outdoor bowling green with planted boundary
14: All weather 9-a-side pitch with fencing
15: All weather full size pitch with fencing and floodlights
16: Grass rugby pitch within terraced sports grounds layout
17: Two full size grass football pitches
18: Grass 9-a-side pitch
19: Landscaped edge to South Road to enhance entrance to the village (accommodating retained library if required)
20: Pocket park as focus for residential area acting as a gateway space and accommodating a new play area with links to the sports club
21: Retained boundary planting
22: Residential square with connections to sports pitches and view to eastern woodlands
23: Landscaped southern edge to the development alongside Public Right of Way
24: Landscaped interface with sports club helping integrate the complementary uses
25: Retained hedge alongside Beach Road

NORTH

5 12.5 25 50 100m
0

A Revisions following team meeting MD31/7/14
Amendments By Date

DRAFT FOR COMMENT

Job No/Drawing No 13162/3007 A
Job Title Sully VOG - St Modwen
Scale 1:2500 @ A3
Date 07/14
Drawn JL/MD
Drawing Title Concept Masterplan
All Dimensions to be checked on site

pad Design Ltd - The Tobacco Factory - Raleigh Road - Bristol BS3 1TF - Tel. 0117 9530059 - www.pad-design.com

Appendix B. Contamination Assessment

SULLY SPORTS AND SOCIAL CLUB
Human Health Screening
Atkins Dervied Residential with Homegrown Produce End-Use (1% SOM) Soil Screening Values

Data Input and Screening

Determinand	Screening Value	Laboratory Results Unit	Method	Accreditation	Method Detection Limit	Exploratory Hole	TP01	TP01	TP03	TP03	TP04	TP05	TP09	TP11	TP11	WS3	WS6	WS12
						Material Description	MG	MS	MG	MS	MS	TPS	TPS	MG	MS	MG	MS	MS
						Depth (m)	0.3	0.6	0.2	0.9	1.5	0.1	0.1	0.3	0.5	0.4	0.5	0.4
						Date Samples	31/07/2014	31/07/2014	31/07/2014	31/07/2014	31/07/2014	31/07/2014	31/07/2014	31/07/2014	31/07/2014	21/07/2014	22/07/2014	22/07/2014
pH	#VALUE!	pH Units		MCERTS	N/A		7.3	7.5	7.5	7.6	7.8	7.6	6.9	7	7.1	7	7.3	7.2
Total Cyanide	34	mg/kg		MCERTS	1		< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Organic Matter	#VALUE!	%		MCERTS	0.1		4.7	-	3.6	-	-	2.2	5.8	-	-		1.6	< 0.1
	#N/A																	
Total Phenols (monohydric)	161.8064545	mg/kg		MCERTS	2		< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
	#N/A																	
Naphthalene	0.585322087	mg/kg		MCERTS	0.05		< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	#VALUE!	mg/kg		MCERTS	0.1		< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	588	mg/kg		MCERTS	0.1		< 0.10	< 0.10	0.98	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	615	mg/kg		MCERTS	0.1		< 0.10	< 0.10	0.68	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.24	< 0.10	< 0.10
Phenanthrene	#VALUE!	mg/kg		MCERTS	0.1		0.6	< 0.10	5.8	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	3.7	< 0.10	< 0.10
Anthracene	8270	mg/kg		MCERTS	0.1		0.13	< 0.10	1.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.94	< 0.10	< 0.10
Fluoranthene	822	mg/kg		MCERTS	0.1		1.4	< 0.10	6.8	0.54	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	6.3	< 0.10	< 0.10
Pyrene	563	mg/kg		MCERTS	0.1		1.1	< 0.10	5	0.39	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	5.3	< 0.10	< 0.10
Benzo(a)anthracene	4.52	mg/kg		MCERTS	0.1		0.77	< 0.10	3.4	0.21	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	3.1	< 0.10	< 0.10
Chrysene	585	mg/kg		MCERTS	0.05		1	< 0.05	3.6	0.36	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	3	< 0.05	< 0.05
Benzo(b)fluoranthene	7.72	mg/kg		MCERTS	0.1		1.1	< 0.10	3.6	0.37	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	3.2	< 0.10	< 0.10
Benzo(k)fluoranthene	84.4	mg/kg		MCERTS	0.1		0.54	< 0.10	2.2	0.15	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	2	< 0.10	< 0.10
Benzo(a)pyrene	0.818394934	mg/kg		MCERTS	0.1		0.82	< 0.10	3	0.24	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	2.9	< 0.10	< 0.10
Indeno(1,2,3-cd)pyrene	7.31	mg/kg		MCERTS	0.1		0.61	< 0.10	2	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	1.7	< 0.10	< 0.10
Dibenz(a,h)anthracene	0.838	mg/kg		MCERTS	0.1		< 0.10	< 0.10	0.36	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.31	< 0.10	< 0.10
Benzo(ghi)perylene	96.2	mg/kg		MCERTS	0.05		0.62	< 0.05	2.2	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	2	< 0.05	< 0.05
	#N/A																	
Speciated Total EPA-16 PAHs	#VALUE!	mg/kg		MCERTS	1.6		8.76	< 1.60	40.7	2.26	< 1.60	< 1.60	< 1.60	< 1.60	< 1.60	34.7	< 1.60	< 1.60
	#N/A																	
Arsenic (aqua regia extractable)	32	mg/kg		MCERTS	1		10	12	10	15	5.9	15	13	11	7.8	15	13	6.6
Beryllium (aqua regia extractable)	60.30949845	mg/kg		MCERTS	0.06		1.3	1.2	0.8	1.1	0.4	0.8	1.4	1.1	1.3	1.1	0.9	1
Cadmium (aqua regia extractable)	10	mg/kg		MCERTS	0.2		1.5	2.2	1.4	5.8	< 0.2	1.4	4.5	2.7	2.2	4.1	1.2	0.2
Chromium (aqua regia extractable)	12800	mg/kg		MCERTS	1		30	46	32	68	14	26	44	30	31	51	26	34
Copper (aqua regia extractable)	3970	mg/kg		MCERTS	1		44	25	39	27	13	39	28	30	19	37	33	20
Lead (aqua regia extractable)	276.1694648	mg/kg		MCERTS	1		79	94	100	210	13	64	170	95	64	170	57	24
Mercury (aqua regia extractable)	170	mg/kg		MCERTS	0.3		< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	130	mg/kg		MCERTS	1		34	26	22	24	12	21	28	27	41	26	26	31
Selenium (aqua regia extractable)	350	mg/kg		MCERTS	1		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	16900	mg/kg		MCERTS	1		180	270	190	400	74	170	430	250	300	320	160	120
	#N/A																	
Benzene	49.33902677	µg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
Toluene	86897.76976	µg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
Ethylbenzene	38164.00096	µg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
p & m-xylene	17927.15743	µg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
o-xylene	18921.52383	µg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
MTBE (Methyl Tertiary Butyl Ether)	20045.15381	µg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
	#N/A																	
TPH1 (C10 - C40)	#N/A	mg/kg		MCERTS	10		17	-	130	-	-	-	-	< 10	-	350	-	-
	#N/A																	
TPH-CWG - Aliphatic >EC5 - EC6	30.06992164	mg/kg		MCERTS	0.1		< 0.1	-	< 0.1	-	-	-	-	< 0.1	-	< 0.1	-	-
TPH-CWG - Aliphatic >EC6 - EC8	69.84785026	mg/kg		MCERTS	0.1		< 0.1	-	< 0.1	-	-	-	-	< 0.1	-	< 0.1	-	-
TPH-CWG - Aliphatic >EC8 - EC10	9.785549851	mg/kg		MCERTS	0.1		< 0.1	-	< 0.1	-	-	-	-	< 0.1	-	< 0.1	-	-
TPH-CWG - Aliphatic >EC10 - EC12	1390	mg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
TPH-CWG - Aliphatic >EC12 - EC16	5100	mg/kg		MCERTS	2		< 2.0	-	< 2.0	-	-	-	-	< 2.0	-	< 2.0	-	-
TPH-CWG - Aliphatic >EC16 - EC21	145000	mg/kg		MCERTS	8		< 8.0	-	< 8.0	-	-	-	-	< 8.0	-	< 8.0	-	-
TPH-CWG - Aliphatic >EC21 - EC35	145000	mg/kg		MCERTS	8		< 8.0	-	19	-	-	-	-	< 8.0	-	49	-	-
TPH-CWG - Aliphatic (EC5 - EC35)	#VALUE!	mg/kg		MCERTS	10		< 10	-	19	-	-	-	-	< 10	-	49	-	-
	#N/A																	
TPH-CWG - Aromatic >EC5 - EC7	0.049339027	mg/kg		MCERTS	0.1		< 0.1	-	< 0.1	-	-	-	-	< 0.1	-	< 0.1	-	-
TPH-CWG - Aromatic >EC7 - EC8	86.89776976	mg/kg		MCERTS	0.1		< 0.1	-	< 0.1	-	-	-	-	< 0.1	-	< 0.1	-	-
TPH-CWG - Aromatic >EC8 - EC10	14.78106024	mg/kg		MCERTS	0.1		< 0.1	-	< 0.1	-	-	-	-	< 0.1	-	< 0.1	-	-
TPH-CWG - Aromatic >EC10 - EC12	57.26356049	mg/kg		MCERTS	1		< 1.0	-	< 1.0	-	-	-	-	< 1.0	-	< 1.0	-	-
TPH-CWG - Aromatic >EC12 - EC16	141.7670072	mg/kg		MCERTS	2		< 2.0	-	4.4	-	-	-	-	< 2.0	-	3	-	-
TPH-CWG - Aromatic >EC16 - EC21	271.5329896	mg/kg		MCERTS	10		< 10	-	28	-	-	-	-	< 10	-	45	-	-
TPH-CWG - Aromatic >EC21 - EC35	888.133881	mg/kg		MCERTS	10		12	-	66	-	-	-	-	< 10	-	240	-	-
TPH-CWG - Aromatic (EC5 - EC35)	#VALUE!	mg/kg		MCERTS	10		12	-	98	-	-	-	-	< 10	-	290	-	-
	#N/A																	

Leachates

Screening value used

Metals and Inorganics

Exceedances of the guideline value

Sample Location	Depth (m bgl)			Stratum	Determinand	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Manganese	Calcium	Magnesium	Potassium	Sodium	Iron	pH	Total Cyanide	Sulphate as SO4	Chloride	Ammoniacal Nitrogen as N	Nitrate as N	Chemical Oxygen Demand (Total)
					Units	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
					Method Detection Limit																					
TP01	0.3	362619				1.80	< 0.08	3.70	5.90	4.30	< 0.5	2.80	16.00	18.00	16.00	1.80	4.40	2.30	1.60	7.2	< 10	1430	< 4.0	< 15	0.6	25
TP03	0.2	362620				5.20	< 0.08	2.00	11.00	4.40	< 0.5	1.80	7.80	5.20	15.00	1.50	8.60	2.80	0.79	7.1	< 10	5870	< 4.0	< 15	0.7	26
TP11	0.3	362621				< 1.1	< 0.08	1.50	5.40	< 1.0	< 0.5	1.40	10.00	7.90	4.10	0.71	0.84	2.60	0.87	7.2	< 10	1960	< 4.0	< 15	0.3	15
WS3	0.4	362622				< 1.1	< 0.08	11.00	4.10	10.00	< 0.5	2.90	49.00	23.00	15.00	1.70	3.80	2.20	1.90	7.1	< 10	1670	< 4.0	< 15	1.8	20
					Number of samples	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
					Minimum value	1.10	0.08	1.50	4.10	1.00	0.50	1.40	7.80	5.20	4.10	0.71	0.84	2.20	0.79	7.10	10.00	1430.00	4.00	15.00	0.30	15.00
					Maximum value	5.20	0.08	11.00	11.00	10.00	0.50	2.90	49.00	23.00	16.00	1.80	8.60	2.80	1.90	7.20	10.00	5870.00	4.00	15.00	1.80	26.00
					Second highest value	1.80	0.08	3.70	5.90	4.40	0.50	2.80	16.00	18.00	15.00	1.70	4.40	2.60	1.60	7.20	10.00	1960.00	4.00	15.00	0.70	25.00
					Range	1.1- 5.2	0.08- 0.08	1.5- 11	4.1- 11	1- 10	0.5- 0.5	1.4- 2.9	7.8- 49	5.2- 23	4.1- 16	0.71- 1.8	0.84- 8.6	2.2- 2.8	0.79- 1.9	7.1- 7.2	10- 10	1430- 5870	4- 4	15- 15	0.3- 1.8	15- 26
					Average concentration	2.30	0.08	4.55	6.60	4.93	0.50	2.23	20.70	13.53	12.53	1.43	4.41	2.48	1.29	7.15	10.00	2732.50	4.00	15.00	0.85	21.50
					Number of exceedances	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					% above assessment criteria	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Assessment criteria	10	5.00	50	2000.00	10	1.0	20	3000	50	-	-	-	200	2.00							
					Source of assessment criteria	DWS	EQS	WFD	EQS	WFD	EQS	EQS	-	-	-	-	-	-	Freshwater DW2							

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