



St. Modwen Developments Limited

Coed Darcy

Phase I Geo-environmental Desk Study

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I Introduction

I.1 General

PJA Engineering has been instructed by St. Modwen Developments Limited (St. Modwen) to prepare a Phase 1 geo-environmental desk study to support a proposed outline planning application for part of the Coed Darcy development site, and to inform the baseline for the ground conditions Environmental Impact Assessment. The Site is outlined in red on Powell Dobson Drawing 21009(05) 100 in Appendix A.

I.2 Development Proposals

The Site is proposed for a mixed end use, comprising residential, commercial, educational and public open space land uses (herein referred to as 'the Proposed Development'). The illustrative masterplan is shown on Powell Dobson Drawing 21009(05) 104 in Appendix A.

I.3 Objectives

This Phase 1 geo-environmental desk study will be used to inform preparation of a ground conditions chapter of an Environmental Impact Assessment and to identify further work required to inform the Proposed Development.

It is intended that this Phase 1 geo-environmental desk study will be submitted to the Local Planning Authority to support an outline planning application for the Proposed Development.

I.4 Scope of Works

This Phase 1 geo-environmental desk study includes:

- Review of geo-environmental and regulatory information and historical maps in a Landmark Envirocheck report obtained for the Site;
- Review of available geo-environmental reports for the Site;
- Establishing the current site condition, geo-environmental setting, historical development, geology, hydrogeology, hydrology and regulatory context;
- Identification of sources, pathways and receptors and preparation of a conceptual site model to establish potential contaminant linkages;
- Completion of a preliminary qualitative risk assessment for the identified potential contamination linkages; and
- Recommendations for further work to investigate potential contaminant linkages and ground engineering constraints.



I.5 Limitations

Where information and data has been used in preparation of this report and has been either provided to PJA or prepared by third parties, PJA accepts no responsibility for the accuracy or completeness of that information.

Further details of the report limitations are presented in Appendix E.



2 Sources of Information

The sources of information used in preparing this desk study are listed in Table 2-1.

Table 2-1: Sources of Information

Description	Author	Date	Reference
Envirocheck report	Landmark	20 August 2021	283848248_1_1
Geoindex	British Geological Survey	Accessed August 2021	https://mapapps2.bgs.ac.uk/geoindex/home.html
Explosive Ordnance Threat Assessment	International Limited	16 th January 2009	9741TA
Flood Risk Assessment Wales Map	Natural Resources Wales	Accessed August 2021	https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk
Coal Mining Report	The Coal Authority	29 September 2021	51002684979001
Coal Mining Risk Assessment	PJA	November 2021	05474-OUT-006
BP Llandarcy Refinery Desk Study	URS	July 2007	44382742/BRRP0001
DiMe Area Controlled Waters Risk Assessment	Atkins	August 2010	5041216-REM-RPT-000372
Monitor Phase 20 Validation Report	Atkins	September 2012	5041216-REM-RPT-000819
Monitor Phase 22 Validation Report	Atkins	March 2013	5041216-REM-RPT-000818
Commercial Area Monitor Phase 28 Validation Report	Atkins	May 2015	5041216-PLOTS-RPT-001016
Monitor Phase 29 Validation Report	Atkins	October 2014	5041216-PH2D-RPT-0001139
Monitor Phase 30 Validation Report	Atkins	October 2014	5041216-PLOTS-RPT-1017
Monitor Phase 31 Validation Report	Atkins	January 2015	5041216-PLOTS-RPT-1284
Monitor Phase 32 Validation Report	Atkins	October 2015	5041216-REM-RPT-0001408
Monitor Phase 33 Validation Report	Atkins	October 2015	5041216-OSW-RPT-0001393
Monitor Phase 39 Validation Report	Atkins	October 2015	5041216-PLOTS-RPT-0001340
Monitor Phase 43 Validation Report	Atkins	October 2015	5041216-PLOTS-RPT-0001405
Monitor Phase 53 Validation Report	Atkins	September 2015	5041216-REM-RPT-0001332
Monitor Phase 54 Validation Report	Atkins	October 2015	5041216-REM-RPT-0001345
Monitor Phase 57 Validation Report	Atkins	October 2015	5041216-OSW-RPT-0001407
Monitor Phase 58 Validation Report	Atkins	October 2015	5041216-OSW-RPT-0001385
Monitor Phase 68 Validation Report	Atkins	October 2015	5041216-OSW-RPT-0001404
Monitor Phase 69 Validation Report	Atkins	October 2015	5041216-OSW-RPT-0001396
Monitor Phase 70 Validation Report	Atkins	October 2015	5041216-OSW-RPT-0001394
Monitor Phase 72 Validation Report	PJA	June 2021	04020-PJA-21-XX-RP-R-0053
Crymlyn Tip - Data Review	PJA	January 2021	n/a
Mine working investigation	Atkins	June 2010	5041216-REM-TN-0336
Investigation of recorded mine entries on upper terrace	Atkins	January 2011	5041216-REM-TN-000494
Geo-Environmental Assessment and Outline Remediation Strategy	Atkins	August 2011	5041216-REM-RPT-000645



Description	Author	Date	Reference
Proposed Persimmon Plot and Upper and Middle Terraces			
RAP Works Schedule 7	N/A	2008	Coed Darcy Section 106 Agreement
RAP Works Completion Reports	Atkins/URS	Various	Various



3 Site Location & Description

3.1 Site Location

The Site addresses approximately 126 hectares of land located off Junction 43 of the M4, approximately 3 miles to the north east of Swansea city centre. Access to the Site is gained via Darcy Business Park off Ffordd Coed Darcy.

The Ordnance Survey grid reference for the approximate centre of the Site is 271190, 195929.

The Site boundary is shown on Powell Dobson Drawing 21009(05) 100 presented in Appendix A.

3.2 Site Description

3.2.1 Current Site Use

The Site primarily comprises areas of vacant land associated with the former Llandarcy Oil Refinery and the area of Proposed Development can be divided into two main areas: North Site and Central Site. North Site is separated from Central Site by a railway cutting which is approximately 13m deep and is spanned by a road bridge and various pipe tracks.

The majority of North Site was formerly used as a tank farm. This area is now mostly vacant, with a cover of scrub vegetation and local stockpiles of material. Operational oil-water separators and a pump house located in a fenced compound are present in the north west of North Site. Overhead powerlines pass through the far west of North Site. The eastern part of North Site is understood to have never been developed historically and currently comprises fields used for grazing by horses. A bowling green is located directly to the south of the fields. Areas of dense vegetation and woodland are present in the north, south east and west of North Site.

To the south of the railway cutting is Central Site, which was formerly occupied by the processing area of the former refinery, railway sidings and the main ancillary buildings such as offices, stores, workshops. In the east of Central Site is a series of office buildings. The remainder of Central Site is mostly vacant, except for material stockpiles which are present locally, a contractor works compound which is located in the north, and South Site Reservoir which is located in the north west. The western and south western margins of Central Site are densely wooded.

Beyond Central Site to the south west is Crymlyn Tip, areas of vacant land and dense woodland. To the south east of Central Site is the Contractors Yard which is accessed via Tank Farm Road and comprises several operational commercial and light industrial units and areas of open storage. Material stockpiles are present in the north and west of the Contractors Yard and plant is currently stored in the southern portion. Crymlyn Tip is discussed further in the PJA technical note included in Appendix G. Whilst they are located within the red line Site boundary, it is understood that the Tip and Contractors Yard are not proposed for development.



3.2.2 Site Boundaries

The northern boundary of North Site is defined by the southern bank of North Site Reservoir, previously used to supply water for firefighting on the refinery, and undeveloped land and woodland in western areas. The southern and western boundaries of North Site are formed by the heavily vegetated railway cutting. Located to the east of North Site is an access track and a vegetated bank, the other side of which is the M4 motorway.

Central Site is generally bound to the north by the railway cutting and to the east by the B4290 Penny-Heol and Llandarcy road. Llandarcy Bog and vacant land of the former oil refinery are located to the south, and Central Site wraps around the recently completed first phase of residential development. The western boundary of Central Site is formed by Crymlyn Bog, which is designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation and RAMSAR site.

3.2.3 Surrounding Area

The areas surrounding the Site are in mixed use. Residential properties of Skewen are located 60m to the east of North Site, beyond the M4 motorway, and 220m to the north of North Site, beyond North Site Reservoir, at their closest point. Residential properties of Coed Darcy extend to the south east from Central Site.

Land to the east of Central Site includes commercial units and leisure facilities such as a hotel, restaurant, sports pitches and a gym, located directly adjacent to the Site boundary at their closest point.

Vacant, undeveloped land of the wider Coed Darcy site extends southwards from the southern Site boundary and Crymlyn Bog extends to the west from the western Site boundary.

3.2.4 Topography

The topography of the Site is highly variable. North Site is domed with the central area at an elevation of approximately 54 metres above Ordnance Datum (maOD), falling away in all directions. The lowest area of North Site is in the south western corner, at an elevation of approximately 29maOD.

Levels across Central Site reflect both the natural topography and earthworks that were carried out to facilitate construction of the former oil refinery. A sandstone ridge is present towards the south of Central Site and a series of terraces were cut into rock to form development plateaus for the refinery. The 'upper terrace' forms the highest point of Central Site, at an elevation of approximately 80maOD, and the ground falls in all directions from this area. The northern, central and eastern parts of Central Site are characterised by gently sloping topography, whilst ground to the west falls sharply to approximately 20maOD at the western Site boundary.



4 Historical Development

4.1 Historical Maps

Historical maps included in the Landmark Envirocheck Report, presented in Appendix B, have been reviewed to establish the historical development of the Site and surrounding area to a distance of 500m. The findings are summarised in Table 4.1.

Table 4-1: Historical Development of the Site and Surrounding Area

Date	Site	Surrounding Area
1878-1881	The Site is largely undeveloped and occupied by fields and Crymlyn Bog. Glan-y-wern Farm is present in the far south of the Site along with an 'old shaft', 'old coal pit' and 'old quarry and old coal pit'. Wern Edmond woodland is recorded in the east along with a spring and a coal pit along the eastern boundary. Tal-y-fedw is present in the north west of Central Site. Cefn Farm is located in the far northeast of North Site.	Surrounding the Site is undeveloped land, predominantly occupied by Crymlyn Bog to the west and southwest and vegetated land with patches of woodland to the north, east and south. Skewen village is located 500m to the north east of North Site. A quarry is located 75m to the south of the Site, close to Glan-y-wern Farm. Henbarc Farm is located approximately 80m to the south east of the Site. A coal pit and coal level are located between 100m and 500m to the east of Central Site. Cae-yr-hendy Farm, Pant-yr-esgyrn Farm, Ty-draw, Farms located to the north of North Site.
1884	No significant changes.	No significant changes.
1899	Coal pit formerly recorded in the east of the Site is recorded as a coal shaft and buildings are present adjacent to the shaft.	Smithy located circa 75m east of the Site boundary. Several quarries are located in the surrounding area: • 125m to the south east • 250m to the south east • 500m to the east The quarry located 75m to the south of the Site is labelled as an Old Quarry. Old quarries are also located 200m and 300m to the south east of the Site. The coal pit, previously recorded 100m east is no longer present. An old coal pit is located circa 325m to the east of the Site. Cwrt-y-bettws Colliery located circa 175m to the east of Central Site in the location of the coal level.
1921	Old coal pits, an old coal shaft and a further old coal pit are recorded along the southern boundary of Central Site. There is no record of shafts or pits within these locations based on previous historical maps. The Great Western Railway line has been constructed between North Site and South Site. The oil refinery is understood to have been constructed by this date but is not shown on	Development of residential properties to the east of the Site (circa 250-325m east). In addition, a significant expansion of the village of Skewen has occurred to within approximately 350m of the north east of North Site. Quarry recorded approximately 200m to the north of North Site.



Date	Site	Surrounding Area
	available mapping, presumably because of the sensitive nature of the land use.	
1938 – 1952	Coal shaft previously recorded within the east of the site no longer recorded.	Llandarcy village has been constructed directly to the south east of the Site. North Site Reservoir is present immediately to the north of North Site. Cwrt-y-bettws Colliery is no longer present to the east of Central Site.
1964 – 1965	The oil refinery is now shown, although it is known to have been present prior to this date. Notable infrastructure includes: • Tanks across North Site and in the northern and southern and western areas of Central Site. • Railway lines and railway sidings across the western part of Central Site and crossing the northern, central and eastern areas of Central Site. • Works in the north, centre and east of Central Site. • An embankment present along the northern boundary of Crymlyn Tip, extending northwards along the western boundary of Central Site. • South Site Reservoir present in the north western corner of Central Site. • Occasional buildings present in the location of the current Contractors Yard in the south of the Site. Based on topographic lines on the historical maps, it appears reprofiling works have taken place to accommodate the refinery.	Tanks extend southwards from the southern Site boundary (referred to as the southern tank farm). The A48 dual carriageway has been constructed directly to the east of Central Site and North Site, on the alignment of the present day M4 motorway.
1970	Crymlyn Tip is labelled as a 'Refuse Tip'.	No significant changes.
1976	Lagoons present in Crymlyn Tip.	No significant changes.
1980	The oil-water separators have been constructed on North Site adjacent to the southern bank of North Site Reservoir.	No significant changes.
1980 – 1989	The Site is labelled as an oil refinery and additional developments are present across Central Site. Further buildings have been constructed in the Contractors Yard. Old shaft, previously recorded along the eastern boundary, no longer present.	No significant changes.
1992	Many of the buildings in the central area of Central Site are no longer present and fewer tanks are present in the western part of North Site.	Residential development of Skewen noted to within 250m of the north of North Site. A sports club, tennis courts and playing fields are located directly to the south east of Central Site at their closest point.



Date	Site	Surrounding Area
		Several tanks immediately beyond the southern boundary no longer present.
1996-1999	Further tanks and buildings have been removed from Central Site. Further buildings have been constructed in the Contractors Yard.	A 'Business Centre' is now present in the east of Central Site, in the location of current commercial units.
2006	The oil refinery is now labelled as 'disused'. Almost all tanks and buildings have been demolished, apart from a small number of structures remaining in the north of Central Site and office buildings in the east of Central Site.	The tanks immediately south of the Site are no longer present.

4.2 Oil Refinery Layout Plans

4.2.1 Available Plans

A series of historical plans showing the layout of the former oil refinery, together with a summary of process operations, are included in the 2007 URS desk study presented in Appendix G. The desk study has been reviewed to determine the historical uses of the Site during the refinery's operation. Drawing 05474-SK-0403, included in Appendix A, shows the historical layout of oil refinery infrastructure at the Site circa 1970.

4.2.1 On-Site

North Site was predominantly used as a tank farm for storage of intermediate and finished products in the east, and for recovered oil in the west from at least the 1950s. In the north west of North Site were oil-water separators and a pumphouse which are still present, receiving water from the Central Site which ultimately discharges to North Site Reservoir via the separators and a drainage channel. An acid tar pit was reported to have been present towards the west of North Site, although this is not labelled on historical plans.

Central Site was the main process area of the oil refinery and as such, a range of infrastructure was historically present with interconnecting aboveground and belowground pipelines.

The main offices and administration buildings, stores, workshops and laboratories were historically present in the eastern part of Central Site at the original entrance to the oil refinery, together with the lube oil blending and dispatch plant, present until the 1980s.

The northern part of Central Site was formerly occupied by a bitumen plant, 'DiMe plant', washeries, a kerosene treatment plant, Edeleanu unit, the main refinery boiler houses/power station and an associated water treatment plant, and the central substation. The DiMe plant used two chlorinated solvents, 1,2-dichloroethane and methylene dichloride (dichloromethane), to remove waxy components from lubricating oil from approximately the 1970s to the late 1990s.



Chlorinated solvents were reported to have been stored in this area in above ground bunded tanks on unsurfaced ground. Until the 1960s, the kerosene treatment plant used sulphuric acid to remove aromatic compounds from kerosene. This generated acid tar as a by-product which was either blended for use as fuel, removed off-site, used in an acid tar burner or stored in the acid tar pit on North Site. The Edeleanu unit was operational from the 1950s to the 1970s and used liquid sulphur dioxide to remove aromatic compounds from kerosene.

Rail sidings entered Central Site in the north western corner, forming a railhead which was aligned north to south along the western edge of the Site. A barrelling plant is reported to have historically been located in the north western corner of the Site adjacent to the sidings from the 1940s to the 1960s, and further south was the lubrication oil pump house, railcar loading depot and associated storage tanks which are understood to have been present from early operations until decommissioning of the refinery.

Various process infrastructure was historically present in the central part of Central Site generally from the 1950s until the late 1980s, including crude oil distillation units, vacuum distillation units, a sulphur recovery plant, hydrofiner units, a liquid petroleum gas unit, catalytic reformers, catalytic cracking plants, and electricity substations. These processes included the initial steps in distillation of crude oil, as well as refining of various distillates to either produce intermediate products requiring further treatment in the refinery, or finished products.

Cooling towers were located in the south of Central Site from the early 1950s. A series of electricity substations were located across North Site and Central Site.

Land within the Site to the south and south west of the main area of Proposed Development, which is intended for use within the Site as a dedicated biodiversity area and as an ongoing Contractors Yard, had various historical uses. Crymlyn Tip located in the far south west of the Site, which was used for disposal of a variety of wastes throughout operation of the oil refinery, forms the majority of the proposed biodiversity area. A summary of available information on Crymlyn Tip is provided in PJA Technical Note in Appendix G. The remainder of the proposed diversity area was occupied by part of the southern railhead with rail loading gantries for lubrication oil and fuel oil, a packaging plant and workshops. It is understood that the Contractors Yard has always been in use for this purpose.

4.2.2 Surrounding Area

The remaining area of the former oil refinery located off-Site was predominantly in use as the southern tank farm, also with rail loading gantries for white oil and Liquid Petroleum Gas (LPG), the tetra-ethyl lead plant, various pumphouses, electricity substations and an LPG loading depot. Aboveground and buried pipework was located across this area. The southern tank farm was used for storage of crude oil and finished products.



4.3 Unexploded Ordnance

Zetica UXO Risk Map (<https://zeticauxo.com/downloads-and-resources/risk-maps/>) indicates the Site to lie within a low risk area; however it is noted as a Luftwaffe Target.

The 2007 URS desk study reports that during World War Two, several storage tanks at the oil refinery were bombed during air raids and caught fire.

In 2009 an Explosive Ordnance Threat Assessment was undertaken by BACTEC International Limited (BACTEC), which indicates *'The Neath area was targeted by the Luftwaffe on numerous occasions, with both HE and incendiary bombs recorded in the region; in addition the locality was heavily defended by HAA batteries. There is therefore a risk of encountering both German aerially-delivered UXO and unexploded Allied anti-aircraft shells UXO over much of the site.'*

BACTEC noted that *"the refinery would have been in constant use during the war and likely subject to stringent post-raid checks... However more peripheral and open areas... may not have been subject to the same levels of access; such areas are at a greater risk of UXO contamination."*

The report is included in Appendix C.

4.4 Records of Military Land Use

The Explosive Ordnance Threat Assessment, included in Appendix C, suggests *'there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with other items of ordnance.'*



5 Geo-environmental Site Setting

5.1 Published Geology

5.1.1 Landscaped Ground

Landscaped ground, defined as *'mainly redeveloped areas and others where extensive earth moving has occurred'*, is shown on published British Geological Survey (BGS) Geoindex mapping to be present across all of the Site, with the exception of the fields in the eastern area of North Site.

5.1.2 Made Ground

Made Ground is not shown on published BGS mapping, however based on the historical use of the Site, Made Ground is anticipated to be present across the majority of the Site associated with previous cycles of development, demolition and earthworks, except for where bedrock is exposed at current ground level and in the fields in the eastern area of North Site.

5.1.3 Superficial Deposits

Published geological mapping indicates that the Site is largely underlain by Till, described by the BGS as *'sandy clay with pebble to boulder-size clasts (diamicton)'*. Peat may encroach on the south western part of the Site. Superficial Deposits are shown to be absent from the *'upper terrace'* in the southern part of Central Site, where bedrock is exposed at current ground level.

5.1.4 Bedrock

Bedrock is recorded as the Brithdir Member, Hughes Member, and Swansea Member of the Pennant Sandstone Formation, described by the BGS as *'green-grey and blue-grey, feldspathic, micaceous, lithic arenites of southerly provenance, with thin mudstone/siltstone and seatearth interbeds and mainly thin coals; the lithologies are commonly arranged in fining-upwards channel-fill sequences.'*

The Hughes and Bodwr coal seams sub-crop at the far south of Central Site. The dip of the solid strata in this area is understood to be towards the north.

5.1.5 Geological Faults

Published BGS mapping indicates that two faults are recorded on Site. A fault is present trending north - south through the Site, at the eastern end of the Tip, in the west of South Site and a second fault is recorded trending north east – south west, at the southern edge of the Contractors Yard.

5.2 Mining

5.2.1 Coal Mining Report

The Landmark Envirocheck Report indicates the Site lies within a coal mining reporting area.

A coal mining report was obtained for the Site from the Coal Authority and is presented in Appendix D. A summary of the report is provided below:

- The Hughes, Swansea No. 3 and an unmade coal seam within the enquiry boundary have been subject to past underground mining at depths ranging from 5m to 131m. The last recorded mining dates range from 1900 to 1914.
- There are no probable unrecorded shallow mine workings.
- Five shafts and an adit are recorded within the enquiry boundary and two further shafts are located directly adjacent to the enquiry boundary. Two shafts located in the north east of Central Site and a shaft located directly adjacent to this area of the Site have undergone treatment involving filling, plugging and capping. There are no records of treatment of mine shafts or the adit in the south of the Site.
- The Hughes, Swansea No. 3 and unnamed coal seams are recorded within the enquiry boundary.
- There are no opencast mines recorded within 500m of the enquiry boundary.
- There are no Coal Authority managed tips recorded within 500m of the enquiry boundary.
- The Coal Authority report records a 'remediated site' located 11.6m to the north west of the enquiry boundary.
- The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50m of the enquiry boundary, since 31 October 1994.
- There is no current Stop Notice delaying the start of remedial works or repairs to the property.
- The Coal Authority is not aware of any request having been made to carry out preventative works before coal is worked under Section 33 of the Coal Mining Subsidence Act 1991.
- There is no recorded mine gas within 500m of the enquiry boundary.
- There are no mine water treatment schemes recorded with 500m of the enquiry boundary.
- There are no records of future underground mining licensing.
- There are no coal mining licenses recorded within 200m of the enquiry boundary.
- No notices have been given, under Section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.
- There is no record of any opencast mines within 500 metres of the Site boundary.
- The property does not lie within the geographical area where a notice to withdraw support has been given.



- The property is not in an area where a notice has been given under Section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.
- The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

The 'remediated site' referenced in the Coal Authority report may refer to treatment of shafts associated with Cwrt-y-Bettws colliery which was historically located to the east of Central Site.

5.2.2 Previous Investigation of Mining Features

Investigation of mining features has previously been undertaken in the south of Central Site. A June 2010 technical note prepared by Atkins indicates that two rotary boreholes drilled to a depth of 30m in the south of Central Site encountered no evidence of coal or redundant/backfilled mineworkings. A subsequent geophysical survey carried out in the south of Central Site, summarised by Atkins in January 2011, identified potential anomalies around the location of a reported shaft. Subsequent trenching in anomaly locations and earthworks cut across the south of Central Site of up to approximately 5m which extended into bedrock found no evidence of a mine shaft. Notwithstanding the results of intrusive works, Atkins concluded in their August 2011 report that should mineworkings exist in the south of Central Site, a sufficient depth of overlying bedrock is present overlying potential mineworkings to prevent the migration of voids to the surface.

Further appraisal of coal mining legacy at the site is presented in the Coal Mining Risk Assessment in Appendix D.

5.3 Radon

The Landmark Envirocheck Report indicates that generally the Site lies within a lower probability radon area as 1% of homes are estimated to be at or above the Action Level. The Envirocheck Report includes entries for intermediate probability radon areas as 3 – 5% of homes are estimated to be at or above the Action Level; however these areas appear to lie beyond the Site boundary.

No radon protection measures are necessary in the construction of new dwellings or extensions in lower probability areas.

5.4 Potential for Geological Hazards

The Landmark Envirocheck Report presents the following geological hazard potential within the Site boundary:

- Potential for Collapsible Ground Stability Hazards: Very low hazard potential to no hazard;
- Potential for Compressible Ground Stability Hazards: High hazard potential to no hazard;
- Potential for Ground Dissolution Stability Hazards: No hazard;



- Potential for Landslide Ground Stability Hazards: Moderate hazard potential to very low;
- Potential for Running Sand Ground Stability Hazards: Very low hazard potential to no hazard; and
- Potential for Shrinking or Swelling Clay Ground Stability Hazards: Very low hazard potential to no hazard.

The high potential for compressible ground hazard coincides with Crymlyn Tip, the existing Contractors Yard and land in the proximity of South Site Reservoir and Crymlyn Bog and may be associated with the presence of peat.

There are several areas within the Site boundary with moderate potential for landslides which may be associated with current topography.

5.5 Hydrogeology

The Landmark Envirocheck Report indicates that Peat is classified by Natural Resources Wales (NRW) as Unproductive Strata, whilst Till is classified as a Secondary (Undifferentiated) Aquifer.

Bedrock of the Pennant Sandstone Formation is classified as a Secondary A Aquifer by NRW.

The Environment Agency defines Unproductive Strata as *'largely unable to provide usable water supplies and are unlikely to have surface water and wetland ecosystems dependent on them.'*

Secondary (Undifferentiated) Aquifers are defined by the Environment Agency as *'aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only minor value.'*

The Environment Agency defines Secondary A Aquifers as *'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.'*

The Envirocheck Report indicates that no active licensed groundwater abstraction points are located within 1000m of the Site and the Site is not located in a groundwater source protection zone.

5.6 Hydrology

5.6.1 Nearest Surface Water Features

South Site Reservoir is located in the north western corner of Central Site. Tal-y-fedw stream is present immediately north of South Site Reservoir, and flows into Crymlyn Bog to the west of the Site. South Site Reservoir was historically used from the 1930s to store process water emanating from an adjacent oil-water separator, and it remains in place today but is no longer receives surface



water discharge from Coed Darcy. The reservoir is understood to now be fed by groundwater flow and the limited outflow discharges to Tal-y-Fedw stream.

A second reservoir, North Site Reservoir, is located directly to the north of North Site. A drainage channel runs along the northern boundary of North Site conveying water from the oil-water separators eastwards, and discharging to the eastern end of North Site Reservoir.

A series of lagoons forming a wetland area is located in the far south west of the Site, to the south of Crymlyn Tip.

A 'peripheral trench' extends along the northern boundary of Crymlyn Tip. The trench was installed to facilitate interception and recovery of oil whilst allowing water to flow into Crymlyn Bog. Oil collected in the trench is recovered using a tractor and bowser and taken off site.

Various other informal ditches and drainage channels are present across the Site.

Crymlyn Bog is located directly to the west of the Site, further information on which is presented in Section 6.5.

The Tennant Canal is located approximately 680m to the east of the Site. The River Neath is located approximately 880m east of the Site, and flows in a southerly direction towards Swansea Bay. During periods of heavy rainfall water levels within North Site Reservoir are controlled by pumping water out of the reservoir and into the River Neath.

5.6.2 Surface Water Abstraction Licences

The Envirocheck Report records two on-Site and one off-Site surface water abstractions. No permit end dates are listed in the Envirocheck Report so it is unknown if the below abstraction licences are still active; however it is understood that only the licence relating to North Site Reservoir remains in use. The surface water abstractions are listed in Table 5-1 below:

Table 5-1: Surface Water Abstraction Licences

National Grid Reference	Distance From Site	Licence Number	Operator	Abstraction Use	Permit Start Date
270100, 195310	On-Site at Crymlyn Bog Lagoon adjacent to Crymlyn Tip	22/59/5/0006	St Modwen Properties Plc	Petrochemicals: General Use (Medium Loss)	29 July 2010
271290, 196340	On-Site at North Site Reservoir pumps	22/59/5/0005	St Modwen Properties Plc	Petrochemicals: Non-Evaporative Cooling	29 July 2010
269880, 194630	612m SW at Freemans Bund	22/59/5/0007	St Modwen Properties Plc	Petrochemicals: Process Water	29 July 2010



5.6.3 Flooding

The majority of the Site lies outside of an area at risk of flooding from rivers and seas without defences. The western part of Crymlyn Tip, located in the far south west of the Site, lies in an area at risk of extreme flooding from rivers and seas without defences (Zone 2).

The Site is largely outside of areas at risk of flooding from surface waters, with the exception of localised areas which are shown to be at low to high risk of flooding from surface waters. It is understood that these risk maps are based on LiDAR data and do not account for engineered drainage, as such there may be some inherent inaccuracy.

The north western corner of Central Site is located in an area at risk of flooding from reservoirs. The flood risk map appears to suggest this is related to North Site Reservoir. The remainder of the Site lies outside of an area at risk of flooding from reservoirs.

The Envirocheck Report records the Site as lying within an area where there is generally limited potential for groundwater flooding to occur, with very localised areas where there is the potential for groundwater flooding of property situated below ground level and potential for groundwater flooding to occur at the surface.



6 Regulatory Review

6.1 Environmental Permits, Incidents and Registers

6.1.1 Local Authority Pollution Prevention and Controls

The Envirocheck Report records seven Local Authority Pollution Prevention and Controls (LAPPC) on-Site. The LAPPC located on-Site are presented in Table 6-1:

Table 6-1: Local Authority Pollution Prevention and Controls

Name	Location	Permit Ref	Date	Process	Description	Status
Onsite						
Cuddy Demolition and Dismantling Limited	Contractors' Yard, off Tank Farm Road in the south of the Site	E3/1/132	21 st April 2008	Local Authority Pollution Prevention and Control	PG3/16 Mobile screening and crushing processes	Permitted
		E3/1/28	31 st October 1995	Local Authority Air Pollution Control		Authorised
		E3/1/139	Not supplied	Local Authority Pollution Prevention and Control		Permitted
		E3/1/103	17 th July 2003	Local Authority Air Pollution Control	PG3/1 Blending, packing, loading and use of bulk cement	Authorised
		E3/1/97	16 th December 2002			
RMC Materials Ltd		E3/1/44	6 th December 2003			
Glass Tech Recycling Ltd		E3/1/119	5 th February 2006	Local Authority Air Pollution Control	PG3/16 Mobile screening and crushing processes	Authorised

The Envirocheck Report shows the Glass Tech facility to be located 30m to the east of the Site, however it is known to be present on-Site in the Contractors' Yard. Furthermore, both the Cuddy and Glass Tech facilities are understood to no longer be operational.

The Envirocheck Report records a 'permitted' LAPPC at Britannic House in the east of Central Site, relating to 'PG6/42 bitumen and tar processes'. It is assumed that this was related to the former bitumen plant in the north of Central Site and was not surrendered on decommissioning and closure.



6.1.2 Discharge Consents

The Envirocheck Report records three 'effective' surface water discharge consents on-Site and a further two within 500m of the Site. Two of the on-Site discharge consents and the two off-Site discharge consents relate to established discharge locations for site drainage, the consents for which are held by St. Modwen. These are located at the northern outfall from South Site Reservoir, at Crymlyn Bog Lagoon in the far south west of the Site, at Crymlyn Bog to the west of the Site and at Llandarcy Bog to the east of the Site. The additional on-Site discharge consent is recorded as being operated by D'Arcy Developments Ltd at the Contractors' Yard in the far south of the Site.

6.1.3 Pollution Incidents to Controlled Waters

The Envirocheck Report records nine pollution incidents to controlled waters within 500m of the Site, with six of the nine related to the Site. These are reported as accurate to 100m.

Two 'Category 1 – Major Incidents' were recorded at Crymlyn Tip in the far south west of the Site on 10th July 1997, resulting from the release of 'Chemicals – Other Organic' and 'Heavy Fuel Oil' to Crymlyn Bog as a result of 'Poor Management Control'.

A 'Category 2 – Significant Incident' was reported on North Site adjacent to the railway line on 1st February 1992, due to the accidental spillage/leakage of 'Chemicals – Other Organic'. The catchment area and receiving water body are not recorded.

Two pollution incidents to controlled waters are recorded on Central Site as 'Category 3 – Minor Incidents' and relate to the release of 'Sewage Debris/Litter' and 'Coal Solids'. The catchment area and receiving water bodies were not recorded for either incident.

A 'Category 3 – Minor Incident' was recorded in the far north east of Central Site on 19th February 1998, relating to the release of 'fire water/foam' as a result of 'fire in the lining of Vacuum Distillation Unit'. The receiving water was indicated as the River Neath.

The remaining three incidents surrounding the Site are all recorded as 'Category 2 – Significant Incidents'. The incidents occurred within approximately 100m of the eastern boundary of Central Site during 1991 and 1992, involving the resale of diesel, light oil and septic tank effluent as a result of 'overflow'. The catchment area and receiving water bodies are not recorded.

6.1.4 Substantiated Pollution Incident Register

The Envirocheck Report records a 'Category 3 – Minor Incident' to land on-Site in the Contractors Yard on 15th August 2002, involving chemically contaminated run-off.



6.2 Planning Hazardous Substance Consents

The Envirocheck Report indicates that there is currently one planning hazardous substance consent located at Britannic House, in the east of Central Site, granted to BP Oil/BP Bitumen between June 1992 and November 1992 for a 'Part C, Flammable Substance'. It is assumed that this consent is no longer active.

6.3 Landfill and Other Waste Sites

6.3.1 Historical Landfills

The Envirocheck Report indicates that there are no recorded historical landfill sites within 500m of the Site.

6.3.2 Registered Landfills

The Envirocheck Report records Crymlyn Tip in the far south west of the Site as a registered landfill, and a Local Authority Recorded Landfill. The landfill is recorded as being authorised to accept 'waste produced on site', which include 'Asbestos/Products, Ion-Exchange Resins, Non-Biodegradable Industrial Wastes, Paper/Products, Plastics, Products, Scrap Metal, Timber/Products.' The maximum input rate is reported as 'Very Small (Less than 10,000 tonnes per year). It is understood that Crymlyn Tip has not accepted waste since 1999 when the oil refinery ceased operation, and it was recorded as 'closed' by the Environment Agency Wales in 2001. Work is ongoing to remediate the landfill and ultimately surrender the Environmental Permit. Further information is provided in the technical note included in Appendix G.

A registered landfill is recorded in the Envirocheck Report directly to the south of the Site relating to landfarming that is known to have been carried out directly to the south west of the Contractors' Yard. Landfarming is no longer operational in this location and the status of the landfill is recorded as 'May not be working/under review'.

The closest off-Site registered landfill is recorded in the Envirocheck Report as 442m north of North Site at an old railway cutting, however the licence is reported as 'lapsed/cancelled/defunct/not applicable/surrendered/cancelled.' Permitted waste is recorded as broken concrete and surplus earthworks material.

6.3.3 Licensed Waste Management Facilities

The Envirocheck Report records three licensed waste management facilities in the south of the Site, located at Crymlyn Tip and the Contractors Yard.

The facility at Crymlyn Tip is recorded as an industrial waste landfill, with the license being issued to St. Modwen Developments Ltd. on 15th November 2017 and the license status reported as 'effective'.

The two licensed waste management facilities at the Contractors' Yard in the south of the Site are operated by Glass Tech Recycling Ltd for the 'treatment of waste to produce soil <75,000 tpy', and by Cuddy Demolition and Dismantling for 'Household, Commercial And Industrial' and 'Special Waste' transfer stations. The licences for both facilities are recorded as 'effective'; however it is understood that neither facility remains operational.

A licensed waste management facility is recorded in the Envirocheck Report in the location of landfarming this was historically carried out adjacent to the Contractors' Yard. The license is listed in the Envirocheck Report as 'surrendered'.

6.3.4 Registered Waste Treatment or Disposal Sites

The Envirocheck Report records an acid tar burnery that was historically located towards the north of Central Site. The license is reported as 'Licence lapsed/cancelled/defunct/not applicable/surrendered/Cancelled'.

6.4 Current Land Use

6.4.1 Contemporary Trade Directory Entries

The Envirocheck report lists five 'active' Contemporary Trade Directory entries within the Site boundary, which are summarised in Table 6-2 below:

Table 6-2: Contemporary Trade Directory Entries

Name	Location	Classification
Contractors Yard		
South Wales Supplies	Unit 5, Contractors Yard, Tank Farm Road	Builders Merchants
Neath Valve & Engineering Co Ltd	Unit 12, Contractors Yard, Tank Farm Road	Valve Manufacturers & Suppliers
Skelton Thomas Engineering Ltd	Celtic Works, Tank Farm Road	Engineers – General
Glass Tech Recycling Ltd	Unit 10, Tank Farm Road	Recycling Services
Britannic House		
Ashworth	Unit E Britannic House, Britannic Way	Air Conditioning Equipment & Systems

The Envirocheck Report lists numerous inactive contemporary trade directory entries within the Site boundary including a mortar manufacturer, engineers, garage services.

'Active' contemporary trade directory entries within 500m of the Site include a laboratory, builders merchant, and a machine supplier in the commercial units off Darcy Business Park.



6.4.2 Fuel Stations

The Envirocheck Report does not record any fuel stations within 500m of the Site.

6.5 Designated Environmentally Sensitive Areas

The Envirocheck Report indicates that Crymlyn Bog, located directly to the west of the Site, is designated by Natural Resources Wales as a Site of Special Scientific Interest (SSSI), a RAMSAR site, a national nature reserve and a Special Area of Conservation.

It is understood that recharge of Crymlyn Bog is via surface water and groundwater.

6.6 Archaeology and Heritage Designations

An archaeological watching brief is understood to have been required during ground investigation undertaken within the undeveloped fields in the east of North Site. No items of archaeological significance are understood to have been identified.



7 Recorded Ground Conditions

7.1 Introduction

Extensive ground investigation has been undertaken at the Site in two main phases. The first ground investigation between 1998 and 2003 was designed by URS on behalf of BP to determine the extent of contamination at the site associated with operation of the oil refinery. Following acquisition of the Site by St. Modwen in 2008, further ground investigation was designed by Atkins on behalf of St. Modwen, in accordance with the requirements of the Section 106 Agreement for the original Coed Darcy development.

The URS ground investigation comprised trial pits, dynamic windowless sampling boreholes and rotary boreholes to characterise Made Ground, superficial deposits and bedrock at the Site. Boreholes were installed with standpipes to enable groundwater sampling and monitoring of groundwater levels.

The Atkins ground investigation comprised trial pits, with the aim of identifying shallow sources of residual soil contamination at the Site. As part of the Atkins ground investigation, the Site was split into a series of 'Monitor Phases'. Dependent on the findings of the Atkins ground investigation, localised remediation was undertaken in the Monitor Phases to target and remove identified sources of residual contamination and to enable validation against either residential, commercial school or public open space standards to the satisfaction of an independent Monitor, in accordance with the requirements of the Section 106 Agreement for the original Coed Darcy development. Remediation and validation was undertaken assuming that ground level represented 1m below finished levels of the development, allowing for placement of a 1m thickness of soils of suitable quality. Whilst the scope of remediation was informed by evidence of contamination and comparison of soil laboratory analytical data with adopted thresholds to identify potentially unacceptable risks to human health, the source removal will also have resulted in a reduction in the residual contamination present in unsaturated soils with the potential to leach to groundwater.

Between the two main phases of ground investigation, and prior to the sale of the site by BP a 'Remedial Action Plan' (RAP) was agreed in 2000 between BP and Environment Agency Wales (predecessor to NRW). Specific elements of the RAP were incorporated into the Section 106 Agreement for the original Coed Darcy development. Specific details relating to the RAP are discussed in Section 7.9.

Recorded ground conditions are summarised in Section 7.2 and Section 7.3. Ground conditions in areas of the Site which are either already developed, such as the areas of office buildings in the east, or are outside of the areas proposed for development, such as the Tip, Contractors Yard and peripheral areas of open space, have not been summarised. A summary of completed remediation and anticipated residual contamination at the Site is provided in Sections 7.4 to 7.7.



Information obtained from the Atkins ground investigation and remediation, included in Appendix G, has predominantly been used to describe current ground conditions because this work was carried out most recently. Supplementary information on bedrock from the URS ground investigation has also been included.

A summary of relevant detailed controlled waters risk assessment undertaken previously is provided in Section 7.8.

7.2 North Site – Ground Conditions

7.2.1 Made Ground

Made Ground was encountered across the majority of North Site as clay, sand and gravel with sandstone gravel and cobbles and anthropogenic inclusions of concrete, brick, shale, coal, clinker, slag, ash, plastic, wire and fabric fragments to depths of between 0.05m in the west and 5.4m bgl in the south. Made Ground was absent from the fields in the east, which is consistent with the absence of known historical development in this area.

7.2.2 Topsoil

Topsoil was identified across the majority of the fields in the east of North Site as silty fine to coarse sand with frequent roots, at thicknesses ranging from 0.1m to 0.5m.

7.2.3 Superficial Deposits

Glacial Till was found to underlie the Made Ground, described as silty gravelly sand, with occasional sandstone cobbles or sandy gravelly silt with occasional sandstone cobbles.

7.2.4 Bedrock

Sandstone bedrock was encountered as a weathered zone comprising clayey sandy tabular sandstone gravel, cobbles and occasional boulders. Where proven the depth to bedrock varied from 0.5m bgl to 5.4m bgl, with rockhead generally becoming shallower towards the north.

Competent bedrock was recorded in a URS borehole at 16.5mbgl in the far south of the North Site fields.

7.2.5 Groundwater

Shallow groundwater in Glacial Till and deeper groundwater in the bedrock aquifer are likely to have a radial flow from the topographical high in the centre of North Site.

7.3 Central Site – Ground Conditions

7.3.1 Made Ground

Made Ground is present across the majority of Central Site and includes material resulting from previous cycles of development and demolition, together with engineered fill associated with remediation and earthworks. The thickness of Made Ground is therefore highly variable.

Existing Made Ground was generally found to be variable in composition, comprising clay, silt, sand, gravel, cobbles and peat with anthropogenic material including ash, brick, clinker, concrete, coal waste, plastic, metal fragments, re-bar and slag. However, along the western margin of Central Site Made Ground was predominantly ashy in nature with clinker, which is consistent with the known presence of an ash bund that was formed to a height of up to approximately 6m to facilitate construction of the former railhead in this area.

Remediation and earthworks have taken place in the central and eastern portions of Central Site, and fill materials included validated Made Ground ‘overburden’ that was removed to allow access to deeper contaminated materials and relict structures, and validated materials won from the wider Coed Darcy site. Validated fill materials placed in these areas generally comprised clay, silt and sand with gravel of sandstone, brick and occasional concrete, and sandstone cobbles.

Made Ground is absent from localised areas in the south and centre of Central Site where earthworks carried out to prepare development plateaus have exposed bedrock at ground level.

7.3.2 Superficial Deposits

Glacial Till predominantly comprising matrices of clay, silt and sand with gravel, cobbles and boulders of sandstone was recorded at proven thicknesses ranging from 3.1m to 5.7m bgl. Discrete layers and pockets of peat were also encountered locally in lower-lying areas in the west of Central Site.

7.3.3 Bedrock

Competent bedrock was typically found to be overlain by a weathered zone comprising clayey silty sandy tabular sandstone gravel, cobbles and boulders. Depth to bedrock generally increases to the north and west across Central Site. Bedrock is exposed at current ground level in the south of Central Site, and locally in the central area. Vertical rock faces are present towards the south of Central Site at the boundary with the completed residential development, and towards the west where the ground drops steeply down to the former railhead.



7.3.4 Groundwater

Groundwater flow on Central Site is likely to be influenced by the topography, the presence of the railway cutting and the regional catchment associated with the River Neath, to the east of Central Site, and Crymlyn Bog to the west of Central Site. Glacial Till is characterised by a flow to the north across much of Central Site. Groundwater in the lower lying areas in the west of Central Site is considered likely to discharge to Crymlyn Bog, with groundwater in the remainder of Central Site flowing to the north and east.

7.4 Residential Remediation

Following completion of ground investigation by Atkins in accordance with the requirements of the original Section 106 Agreement, a portion of Central Site was remediated and validated to a residential standard between 2014 and 2018, together with the existing fields in the east of North Site in 2015, as shown in green on Drawing 05474-SK-0402 presented in Appendix A.

Soils in the North Site fields were validated as suitable for a residential end use at 1m below finished levels, without the requirement for remediation. In the south of Central Site and locally in the west, the exposed sandstone bedrock surface was validated against residential standards at 0.5m below finished levels via visual inspection and use of a photo-ionisation detector, without the requirement for remediation, as agreed with the Monitor.

In the lower-lying areas of Central Site that were validated to a residential standard, TPH, PAH and asbestos contamination requiring remediation was identified. Excavation of in situ soils was carried out either to bedrock or to suitably validated underlying soils, whichever was the shallower. Remediation excavations were validated either via visual and olfactory inspection and laboratory analysis of validation samples taken from the excavation faces and base in accordance with the original Section 106 Agreement, or by extending excavations to the locations of material that had been identified in the ground investigation as suitable for retention.

Validated excavations were backfilled by the placement and compaction of materials derived from the wider Coed Darcy site that were validated for use in a residential area at depths greater than 1m below finished levels in accordance with the original Section 106 agreement. Fill materials included sandy clay and silt and silty sand with gravels and cobbles of sandstone, brick and occasional concrete. Validation reports were submitted to and approved by the Monitor who issued Redevelopment Remediation Works Completion Certificates, included in Appendix J.

There are anticipated to be no unacceptable levels of contamination present in the area of the fields in the east of North Site based on the extensive dataset and lack of historical development in this area. In the areas of Central Site remediated to a residential standard, validation was carried out in accordance with the original Section 106 Agreement on the assumption that a clean cover system



will be placed in the finished development above current ground levels. As such, the current in situ soils have not undergone validation for inorganic contaminants such as metals, and recorded levels of residual organic contamination will require the presence of clean cover soils to mitigate risks associated with direct contact migration pathways.

Where earthworks associated with the Proposed Development include areas of extensive cut, further assessment of contamination may be required. It should be noted that some upgraded remediation to residential standards in Central Site post-dated the Monitor sign-off exercise and has not all been formally reported.

It is acknowledged that development-specific submissions will be required as part of the Reserved Matters planning process.

7.5 Commercial Remediation

Following completion of ground investigation by Atkins in accordance with the requirements of the original Section 106 Agreement, the majority of North Site and areas in the east, centre and north of Central Site were remediated and validated to a commercial standard between 2012 and 2015, as shown in yellow on Drawing 05474-SK-0402, presented in Appendix A.

Hydrocarbon-impacted soils and localised occurrences of free-phase hydrocarbons were identified during Atkins' ground investigations on North Site and Central Site which required remediation. Gross soil contamination which was considered to be unacceptable in the context of a commercial end use was generally present locally as hotspots rather than being laterally extensive across a wide area. This is likely to reflect the typical historical sources of contamination such as local uncontrolled releases from pipework, storage tanks and process areas during operation of the oil refinery, and potentially during decommissioning and demolition.

Excavation of contaminated in situ soils was carried out either to bedrock or to suitably validated underlying soils, whichever was the shallower.

Where bedrock was exposed during removal of contaminated soils, excavations were left open to enable observations to be made of potential mobile free-phase hydrocarbon ingress. Mobile free-phase hydrocarbons were typically present only as minor seepages from fractured bedrock and not in sufficient volumes for recovery. Where mobile free-phase hydrocarbons were associated with groundwater, pumping was carried out until no further ingress of hydrocarbons was observed. Viscous free-phase hydrocarbons were present locally and were commonly encountered as isolated pockets within hydrocarbon-saturated soils which required excavation.

Remediation excavations were validated via visual and olfactory inspection and laboratory analysis of validation samples taken from the excavation faces and base in accordance with the original Section 106 agreement. Where backfill of validated excavations was required, this was carried out



by the placement and compaction of materials derived from the wider Coed Darcy site that were validated for use in a residential area at depths greater than 1m below finished levels, in accordance with the original Section 106 agreement. Validation reports were submitted to and approved by the Monitor who issued Redevelopment Remediation Works Completion Certificates, included in Appendix J.

Residual contamination in areas remediated to a commercial standard is anticipated to comprise organic contaminants and asbestos. The current in situ soils have not undergone validation for inorganic contaminants such as metals, on the assumption that a clean cover system will be placed in the finished development above current ground levels to mitigate direct contact migration pathways.

Where areas validated to commercial standards coincide with proposed residential development, there will be a requirement for further assessment taking into account proposed earthworks and development levels to identify areas of unacceptable contamination requiring remediation.

In areas of proposed commercial development requiring earthworks with areas of extensive cut, further assessment of residual contamination may be required.

It is acknowledged that development-specific submissions will be required as part of the Reserved Matters planning process.

7.6 School Remediation

Following completion of ground investigation by Atkins in accordance with the requirements of the original Section 106 Agreement, a portion of Central Site was remediated and validated to a school standard in 2015, as shown in pink on Drawing 05474-SK-0402, included in Appendix A.

Hydrocarbon-impacted soils, asbestos, and localised occurrences of free-phase hydrocarbons were identified during Atkins' ground investigations on Central Site which required remediation. Gross soil contamination which was considered to be unacceptable in the context of a school end use was generally present locally as hotspots rather than being laterally extensive across a wide area. This is likely to reflect the typical historical sources of contamination such as local uncontrolled releases from pipework, storage tanks and process areas during operation of the oil refinery, and potentially during decommissioning and demolition.

Excavation of contaminated in situ soils was carried out either to bedrock or to suitably validated underlying soils, whichever was the shallower. During remediation, a contaminant hotspot of disulphide compounds was encountered which was characterised by strong, pungent odours, markedly different from petroleum hydrocarbons. Contaminated soils were removed on a visual and olfactory basis, and excavations extended into unaffected soils.



Where bedrock was exposed during removal of contaminated soils, excavations were left open to enable observations to be made of potential mobile free-phase hydrocarbon ingress. Mobile free-phase hydrocarbons were typically present only as minor seepages from fractured bedrock and not in sufficient volumes for recovery.

Remediation excavations were validated via visual and olfactory inspection and laboratory analysis of validation samples taken from the excavation faces and base in accordance with the original Section 106 agreement. A validation report was submitted to and approved by the Monitor who issued a Redevelopment Remediation Works Completion Certificate, included in Appendix J.

The current in situ soils have not undergone validation for inorganic contaminants such as metals, on the assumption that a clean cover system will be placed in the finished development above current ground levels to mitigate direct contact migration pathways.

Where earthworks associated with the Proposed Development include areas of extensive cut, further assessment of contamination may be required. It should be noted that some upgraded remediation to residential standards in Central Site post-dated the Monitor sign-off exercise and has not all been formally reported.

It is acknowledged that development-specific submissions will be required as part of the Reserved Matters planning process.

7.7 Public Open Space Remediation

On North Site and Central Site, areas of open water, areas of existing soft landscaping and woodland that will be retained, together with the northern and lower western areas of Central Site were remediated and validated to a public open space standard, as shown in blue on Drawing 05474-SK-0402. In situ soils were validated for a public open space end use, with a requirement to place clean cover soils locally in areas of soft landscaping.

Localised remediation was undertaken between 2011 and 2014 in the former DiMe plant located in the north of Central Site, including excavation of grossly contaminated soils characterised by evidence of contamination and/or exceedances of the adopted assessment criteria, and extraction via pumping of chlorinated solvent-impacted shallow groundwater. Remediation included excavation of a trench along the northern edge of the works and installation of lined sumps to intercept and allow recovery of contaminated shallow groundwater.

Remediation excavations were validated via visual and olfactory inspection and laboratory analysis of validation samples taken from the excavation faces and base in accordance with the original Section 106 agreement, and via trial pitting following backfill. Backfill of validated excavations was achieved by the placement and compaction of materials derived from the wider Coed Darcy site that were validated for use at depths greater than 1m below finished levels in accordance with the



original Section 106 Agreement. Validation reports were submitted to and approved by the Monitor who issued Redevelopment Remediation Works Completion Certificates, included in Appendix J.

Residual contamination in the former DiMe plant is likely to comprise chlorinated solvents, together with the more commonly-encountered contaminants such as polycyclic aromatic hydrocarbons and petroleum hydrocarbons. Chlorinated solvents are 'dense non-aqueous phase liquids' which will migrate downwards through unsaturated soils and then through the water column rather than floating on the water table, interrupted only by impermeable soil layers. Dispersed and disconnected pools of free phase chlorinated solvents may therefore be present resting on cohesive soils where these have not been intercepted by previous free-phase recovery works. Residual contamination will also be present in groundwater as a result of dissolving free-phase chlorinated solvents. Additionally, residual soil-derived and groundwater-derived vapours may be present.

Residual contamination in the remaining areas that were validated for a public open space end use will be variable depending on the proximity to areas of former oil refinery infrastructure and the presence, thickness and composition of soils overlying bedrock. In the low-lying area in the west of Central Site formerly occupied by the railhead, residual free-phase hydrocarbons may be present locally within the ashy Made Ground. Beyond the railhead, more localised pockets of free-phase hydrocarbons may remain, together with hydrocarbon and asbestos contamination in soils.

Where areas validated for public open space coincide with Proposed Development for a residential or educational end use, there will be a requirement for further assessment taking into account proposed earthworks and development levels to identify areas of unacceptable contamination requiring remediation.

It is acknowledged that development-specific submissions will be required as part of the Reserved Matters planning process.

7.8 Controlled Waters Detailed Quantitative Risk Assessment

Controlled waters detailed quantitative risk assessment (DQRA) was undertaken by Atkins in 2010 for the area of the former DiMe plant in the north of Central Site. Based on the groundwater monitoring data available at the time, the DQRA identified priority contaminants as chlorinated solvents dichloromethane and 1,2-dichloroethane, and aromatic petroleum hydrocarbon fractions C10-C12 and C12-C16.

Atkins concluded that there were no discernible risks from dichloromethane and TPH aromatic C12-16. Potential risks to controlled waters were identified from 1,2-dichloroethane and TPH aromatic C10-C12, only if contamination was modelled as a 'constant' source without accounting for degradation. Recovery of free phase hydrocarbons was recommended, together with monitoring to inform the requirement for remediation of 1,2-dichloroethane and TPH aromatic C10-C12



contamination. Remediation subsequently undertaken in the area of the former DiMe plant is summarised in Section 7.6.

7.9 Remediation Action Plan (RAP)

The remaining requirements of the BP RAP were required to be delivered by St. Modwen and were included in Schedule 7 of the Section 106 Agreement between Neath Port Talbot and St. Modwen.

Schedule 7 of the RAP is included as Appendix I.

In summary the RAP was a programme of voluntary remediation elements which principally addressed gross contamination at the margins of the site. Activities involved variously:

- Removal of oily sludge;
- Renovation of water bodies;
- Installation of oil interception features; and
- Investigations of sources of mobile free phase product.

Appendix I contains the Section 106 RAP plan showing the location of the RAP features. The Coed Darcy Monitor was required to oversee completion of each of the RAP elements and produce a RAP Works Completion Certificates for each element.

Monitor Completion Certificates and supporting documents from St. Modwen's consultant Atkins are provided in Appendix K.

Although the RAP programme of works was not incompatible with the Coed Darcy development, the works were not originally intended as a programme of works to enable the wider development area to be suitable for redevelopment.

The original RAP works covered the whole of the former Llandarcy oil refinery. The RAP elements considered relevant to the Proposed Development at the Site are summarised below. The reference numbers relate to RAP numbering indicated in Section 7 of the previous Section 106 Agreement.

RAP - 1 and 24 North Site Sentinel Well Installation

These works were undertaken to understand the likelihood for product migration from the former operational site to either the railway cutting or North Site Reservoir. The reports demonstrated that the risk related to significant migration of free phase was low. No product collection trenches were required to be installed.

Works were completed to the satisfaction of the Monitor.



RAP – 2, 3, 4 and 5 – Western Margin – Well and Trench Monitoring

These works were focused on the northern and western areas of the former railhead and involved the monitoring of new and existing wells, excavations and trenches to examine the impacts of residual free phase oil.

Works were completed to the satisfaction of the Monitor.

RAP – 18 – API Separators

These works involved the removal of sludge elements from the redundant American Petroleum Institute (API) separators which are located adjacent the North Site Reservoir. The separator structures themselves remained in-situ.

Works were completed to the satisfaction of the Monitor.

RAP – 21 – South Site Reservoir

These works involved the drawing down of water from South Site Reservoir and the removal of impacted sludge and contaminated materials.

Works were completed to the satisfaction of the Monitor.

RAP – 19 and 24 – DIME

These works involved the assessment of the drainage connections and the impacts of chlorinated solvent contamination. These works involved further investigations, monitoring and undertaking controlled waters risk assessments. Additional remediation works were not considered necessary.

Works were completed to the satisfaction of the Monitor.



8 Conceptual Site Model

Based on the information summarised in the preceding sections of this report, this section presents the sources of potential contamination, receptors to potential contamination and pathways between the two. The Conceptual Site Model has been developed using this commonly adopted source-pathway-receptor model, as recommended in Land Contamination: Risk Management published by the Environmental Agency in 2020.

Where contamination sources, receptors, and pathways are present, these are referred to as potential contaminant linkages.

A preliminary assessment of the risk posed to identified receptors from potential on-Site and off-Site contamination sources has been made for each potential contaminant linkage, based on the information available at the time of writing this report.

8.1 Potential Sources of Contamination

8.1.1 On-Site

On-Site potential sources of contamination are considered to comprise:

- Made Ground associated with historical development and demolition of oil refinery infrastructure and in the operational Contractors Yard;
- Contaminated natural soils associated with releases to ground from historical oil refinery infrastructure and the operational Contractors Yard;
- Dissolved-phase contamination in groundwater associated with releases to ground from historical oil refinery infrastructure and the operational Contractors Yard;
- Free-phase petroleum hydrocarbons and chlorinated solvents associated with releases to ground from historical oil refinery infrastructure;
- Soil-derived and groundwater-derived vapours associated with releases to ground from historical oil refinery infrastructure and the operational Contractors Yard;
- Waste materials and free phase hydrocarbons in Crymlyn Tip;

Oil refinery infrastructure that was historically present on-Site is discussed in Section 4.2.2.

The range of contaminants associated with the identified contamination sources is likely to include metals and other inorganics, asbestos, oils, fuels and grease (Total Petroleum Hydrocarbons), polycyclic aromatic hydrocarbons, and locally, polychlorinated biphenyls and chlorinated solvents. Methane and carbon dioxide may be associated with Crymlyn Tip, localised peat, the natural degradation of residual petroleum hydrocarbons and potentially mine gas associated with mineworkings.



8.1.2 Off-Site

The key off-Site potential sources of contamination are considered to comprise:

- Contaminated soil, groundwater, free-phase hydrocarbons and potential vapours associated with the former southern tank farm and other refinery infrastructure, located directly to the south of the Site.

Potential contaminants associated with these off-site land uses could include metals and other inorganics, asbestos, oils, fuels and grease (Total Petroleum Hydrocarbons), polycyclic aromatic hydrocarbons and polychlorinated biphenyls. The natural degradation of residual petroleum hydrocarbons may result in the generation of methane and carbon dioxide.

The off-Site potential sources of contamination are noted to be at a lower elevation and down-gradient of the Site. However, these potential contamination sources have not been discounted from the conceptual site model.

8.2 Potential Pathways

8.2.1 Human Health

Regarding the assessment of risk to human health, the following pathways are considered to be potential exposure routes based on the assumed residential end use:

- Ingestion of contaminants in soil and soil-derived dust;
- Dermal contact with contaminants in soils and soil-derived dusts where soils (and contaminants) are exposed at the surface;
- Inhalation of contaminants in soil-derived dusts from areas where soils (and contaminants) are exposed at the surface; and
- Inhalation of soil-derived and groundwater-derived vapours and/or ground/landfill gas.

8.2.2 Controlled Waters

The following pathways for the migration of contamination to controlled waters are considered applicable:

- Leaching and migration of contaminants from soils in the unsaturated zone into groundwater in the underlying aquifers;
- Migration of contaminants via preferential pathways such as piles to groundwater in the underlying aquifers;
- Lateral migration of contaminants in groundwater through soils and bedrock with discharge to surface water as base flow; and

- Migration of contaminants along preferential pathways such as installed services followed by discharge to surface watercourses.

8.2.3 Property

The following pathways are considered applicable for property receptors:

- Direct contact of on-Site property with contaminants in soils, perched water and/or groundwater;
- Direct contact of off-Site property with contaminants in migrating perched water and/or groundwater; and
- Lateral/vertical migration of gas through soils followed by accumulation in enclosed spaces and potentially explosive conditions.

8.3 Potential Receptors

Potential receptors to contamination are presented in Table 8-1, based on the proposed development of the Site.

Table 8-1: Potential Receptors

Receptor Type	Description
Human Health	Occupants of future on-Site residential properties
	Workers in and visitors to on-Site commercial properties, members of the public using on-Site public open space
	Occupants and visitors to off-Site residential properties, commercial properties, public open space
	Construction and maintenance workers
Controlled Waters	Groundwater in Secondary (Undifferentiated) and Secondary A Aquifers
	Surface water in South Site Reservoir, Tal-y-Fedw, wetland lagoons, North Site Reservoir, Crymlyn Bog, Tennant Canal and River Neath
Property	Current and future on-site buildings, foundations and services
	Current and future off-site buildings, foundations and services
Ecological	Crymlyn Bog SSSI

Whilst construction and maintenance workers are considered to be potential receptors to contamination, their exposure is considered to be acute based on the generally short duration of their work.

Land contaminated risk assessment is based on chronic risks associated with exposure to contamination over a longer period of time, therefore risks to construction and maintenance workers are not considered in the conceptual site model.



8.4 Preliminary Conceptual Site Model and Risk Assessment

Based on the information currently available, potential contaminant linkages have been identified and a preliminary risk assessment has been undertaken for the site. The estimation of the potential significance of each linkage is based on the nature of the Proposed Development, the presence and mobility of potential contaminants and the plausibility of the identified migration/exposure pathways.

The preliminary risk assessment was undertaken in accordance with the risk matrix set out in CIRIA C552 and is presented in Table 8-2. Risk Classification used to inform the preliminary risk assessment is presented in Appendix F.

**Table 8-2: Conceptual Site Model and Preliminary Risk Assessment**

Pollutant Linkage	Potential Source	Key Contaminants	Pathway	Receptor	Probability	Consequence	Risk	Rationale
1	On-Site Made Ground associated with historical development and demolition of oil refinery infrastructure. and in the operational Contractors Yard	Metals and other inorganics, asbestos, oils, fuels and grease (Total Petroleum Hydrocarbons), polycyclic aromatic hydrocarbons, polychlorinated biphenyls, chlorinated solvents	Dermal contact with and/or ingestion of contaminants in soil and soil-derived dust	Human – occupants of future on-Site residential properties	High likelihood	Medium	High	Residual contamination is present as a result of the historical use of the Site as an oil refinery. Gross contamination has been removed as part of previous phases of remediation. There are some areas of the site proposed for residential development which have been not undergone remediated to a residential standard and there is therefore considered to be a high likelihood of the contaminant migration pathways between contamination sources and receptors being realised.
2	Contaminated natural soils associated with releases to ground from historical oil refinery infrastructure and the operational Contractors Yard. Dissolved-phase contamination in groundwater associated with releases to ground from historical oil refinery infrastructure and the operational Contractors Yard.		Inhalation of contaminants in soil-derived dust	Human – workers in and visitors to on-Site commercial properties, members of the public using on-Site public open space	Unlikely	Medium	Low	Residual contamination is present as a result of the historical use of the Site as an oil refinery. Gross contamination has been removed as part of previous phases of remediation. Surface cover at the Site currently comprises mostly vacant land with scrub vegetation. There are currently no earthworks taking place on the vacant land. Locally there are also areas of existing commercial units, external hardstanding and well-vegetated soft landscaping. It is considered unlikely that site users will come into contact with contaminants in soil via the dermal contact, ingestion or inhalation pathways under current use of the Site.
			Inhalation of vapours					
3	Free-phase petroleum hydrocarbons and chlorinated solvents associated with releases to ground from historical oil refinery infrastructure.		Dermal contact with and/or ingestion of contaminants in windblown soil-derived dust	Human – occupants and visitors to off-Site residential properties, commercial properties, public open space	Unlikely	Medium	Low	Residual contamination is present as a result of the historical use of the Site as an oil refinery. Gross contamination has been removed as part of previous phases of remediation. Surface cover at the Site currently comprises mostly vacant land with scrub vegetation. There are currently no earthworks taking place on the vacant land. Locally there are also areas of existing commercial units, external hardstanding and well-vegetated soft landscaping. Based on the current Site condition and use, it is considered unlikely that windblown, soil-derived dust will be generated and migrate to off-Site human receptors. Under current site conditions it is also considered unlikely that vapours which may be associated with residual on-Site contamination will migrate to off-Site human receptors.
			Inhalation of contaminants in windblown soil-derived dust					
			Inhalation of migrating vapours					
4	Soil-derived and groundwater-derived vapours associated with releases to ground from		Leaching and migration of contaminants from soils in the unsaturated zone into groundwater	Controlled Waters – groundwater in Secondary (Undifferentiated) and Secondary A Aquifers	Likely	Medium	Moderate	Residual contamination is present as a result of the historical use of the Site as an oil refinery. Gross contamination has been removed as part of previous phases of remediation. Underlying bedrock is classified as a Secondary A Aquifer and, where present, superficial deposits are classified as a Secondary



Conceptual Site Model

Pollutant Linkage	Potential Source	Key Contaminants	Pathway	Receptor	Probability	Consequence	Risk	Rationale
	historical oil refinery infrastructure and the operational Contractors Yard.		Migration of contaminants via preferential pathways such as piles to groundwater					(Undifferentiated) Aquifer. The site is not located in a groundwater source protection zone. The site is largely unsurfaced at present meaning there is potential for the generation of mobile or leachable contamination from residual contamination in unsaturated soils which may migrate into the underlying aquifers.
5	Waste materials and free phase hydrocarbons in Crymlyn Tip.		Lateral migration of contaminants in groundwater through soils and bedrock with discharge to surface water receptors as base flow	Controlled Waters – surface water in South Site Reservoir, Tal-y-Fedw, wetland lagoons, North Site Reservoir, Tennant Canal and River Neath	Unlikely	Medium	Low	Residual contamination is present as a result of the historical use of the Site as an oil refinery. RAP works carried out as part of the original Coed Darcy development were designed to recover gross contamination and mitigate risks associated with migration of mobile contamination at the Site boundaries. It is therefore considered unlikely that significant residual contamination is actively migrating to the identified surface water receptors.
6			Migration of contaminants along preferential pathways such as installed services followed by discharge to surface water receptors	Controlled waters and ecological – Crymlyn Bog SSSI	Low likelihood	Medium	Moderate/low	Residual contamination is present as a result of the historical use of the Site as an oil refinery. Crymlyn Tip which is located directly adjacent to and up-hydraulic gradient of part of Crymlyn Bog SSSI, is a source of free phase hydrocarbons which are currently captured via an active oil recovery system. Additionally, RAP works carried out as part of the original Coed Darcy development were designed to recover gross contamination and mitigate risks associated with migration of mobile contamination at the Site boundaries. There is therefore considered to be a low likelihood of contamination migrating into Crymlyn Bog taking into account the RAP works and whilst the oil recovery system remains operational.
7			Direct contact with contaminants in soils, perched water and/or groundwater	Current and future on-Site buildings, foundations and services	Low likelihood	Mild	Low	Residual contamination is present as a result of the historical use of the Site as an oil refinery. Gross contamination has been removed as part of previous phases of remediation. There is the potential for risks to potable water supply pipework which may require barrier pipe. The site is not directly underlain by key sulphate-bearing strata and it is considered unlikely that there are risks from aggressive ground to concrete.
8			Direct contact with contaminants in migrating perched	Off-Site buildings, foundations and services	Low likelihood	Mild	Low	Mobile contamination, if present, may have migrated off-Site but there is considered to be a low likelihood that there is an ongoing impact to



Pollutant Linkage	Potential Source	Key Contaminants	Pathway	Receptor	Probability	Consequence	Risk	Rationale
			water and/or groundwater					off-Site buildings which are generally located at a higher elevation than the Site.
9	<u>On-Site and off-Site</u>	Methane Carbon dioxide Radon	Lateral/vertical migration through soils followed by accumulation in enclosed spaces leading to potentially asphyxiating atmosphere	Human – occupants of future on-Site residential properties	Low likelihood	Medium	Moderate/low	There is considered to be a low likelihood that ground/landfill/mine gas is present in areas of the Site proposed for development in sufficient quantities in enclosed spaces to result in potentially asphyxiating atmospheres.
10	Ground/landfill/mine gas			Human – workers in and visitors to on-Site commercial properties	Low likelihood	Medium	Moderate/Low	The Site generally lies within a lower probability radon area as 1% of homes are estimated to be at or above the Action Level. Radon protection measures are unlikely to be necessary in the construction of new dwellings or extensions in lower probability areas, subject to conformation of the level of risk.
11	<u>On-Site and off-Site</u> Ground/landfill/mine gas	Methane Carbon dioxide Radon	Lateral/vertical migration through soils followed by accumulation in enclosed spaces leading to potentially explosive conditions	On-Site and off-Site properties	Low likelihood	Severe	Moderate/Low*	There is considered to be a low likelihood that ground/landfill/mine gas is present in areas of the Site proposed for development in sufficient quantities in enclosed spaces to result in potentially explosive conditions. * The lowest achievable risk level for a 'severe' 'low likelihood' scenario is 'moderate', however this has been adjusted to 'moderate/low' based on professional judgement of the level of risk.
12	<u>Off-Site</u> Contaminated soil, groundwater, free-phase hydrocarbons and potential vapours associated with the former southern tank farm and other refinery infrastructure, located directly to the south of the Site	Total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, chlorinated solvents, polychlorinated biphenyls and asbestos	Dermal contact with and/or ingestion of contaminants in windblown soil-derived dust	Human – occupants of future on-Site residential properties	Low likelihood	Medium	Moderate/Low	Historical potentially contaminative land uses have been identified in to the south of the Site. Migration pathways to on-Site human receptors are generally considered unlikely to be realised as the area to the south is at a lower elevation and down-hydraulic gradient from the Site, however migration of contaminants in windblown soil-derived dust is considered plausible.
13			Inhalation of contaminants in windblown soil-derived dust	Human – workers in and visitors to on-Site commercial properties, members of the public using on-Site public open space	Unlikely	Medium	Low	
			Inhalation of migrating soil-derived and groundwater-derived vapours					
14			Lateral migration of contaminants in groundwater	Controlled Waters – groundwater in Secondary (Undifferentiated) and Secondary A Aquifers	Unlikely	Medium	Low	Potential off-Site sources of contamination have been identified, however these are down-hydraulic gradient of the Site to the south and are therefore unlikely to have resulted in contamination of groundwater underlying the Site.
			Migration of contaminants via					



Conceptual Site Model

Pollutant Linkage	Potential Source	Key Contaminants	Pathway	Receptor	Probability	Consequence	Risk	Rationale
			preferential pathways to groundwater					
15			Direct contact with contaminants in migrating perched water and/or groundwater	On-Site buildings, foundations and services	Unlikely	Mild	Very low	Potential off-Site sources of contamination have been identified, however these are down-hydraulic gradient of the site to the south and south-west and are therefore unlikely to have resulted in contamination of groundwater underlying the Site. The surrounding area is not directly underlain by key sulphate-bearing strata it is considered unlikely that there are risks from aggressive ground to concrete.



9 Conclusions and Recommendations

9.1 Conclusions

The desk study has identified potential sources of contamination at the site as a result of the historical use of the Site as an oil refinery, together with a series of human, controlled waters, ecological and property receptors. A substantial amount of data exists for the Site as a result of extensive ground investigation and subsequent targeted remediation, which is recorded in a number of technical notes and reports which have been reviewed in preparing this desk study. Residual contamination is anticipated to exist at variable concentrations across the Site, and is anticipated to include petroleum hydrocarbons, polycyclic aromatic hydrocarbons, asbestos, metals and locally chlorinated solvents. A controlled waters detailed quantitative risk assessment has previously been completed for areas of Central Site which concluded that there were no unacceptable risks to controlled waters receptors within the River Neath catchment.

A preliminary conceptual model and qualitative risk assessment suggests the following levels of risk to the identified receptors:

Table 9-1: Preliminary Risks to Identified Receptors

Receptor Type	Description	Preliminary Risk Level
Human	Future on-Site and current off-site residents	High to Low
	Current and future workers in on-Site and off-Site commercial properties	Moderate/low to Low
	Members of the public using future on-Site and current off-Site areas of open space	Low
	Construction and maintenance workers	N/A - acute risk to construction and maintenance workers not assessed.
Controlled Waters	South Site Reservoir, Tal-y-Fedw, wetland lagoons, North Site Reservoir, Tennant Canal and River Neath	Low
	Groundwater in Secondary A Aquifer and Secondary (Undifferentiated) Aquifer	Moderate to low
Controlled Waters and Ecological	Surface water in Crymlyn Bog	Moderate/low
Property	Current and future on-site buildings, foundations and services	Moderate/low to very low
	Current and future off-site buildings, foundations and services	Moderate/low to low

9.2 Recommendations

A range of further works are recommended to identify potentially unacceptable risks to identified receptors, refine the conceptual site model, determine the requirement for and scope of remediation, and additionally to inform detailed design of the Proposed Development from a ground engineering perspective.



Requisite information for the full assessment of risk to the identified receptors in the context of the Proposed Development includes a defined masterplan, finished ground levels and the associated cut-fill strategy.

It is recommended that the following tasks are undertaken:

- Derivation of site assessment criteria (SAC) for human health to inform the assessment of laboratory analytical data for in situ soils and for use in the validation of remediation (refer to technical note presented in Appendix H);
- Review of available exploratory hole logs and laboratory analytical data to establish the presence and extent of residual contamination;
- Identification of geo-environmental and geotechnical data gaps;
- Scoping and completion of the necessary ground investigation, gas monitoring, groundwater sampling and vapour sampling to fill data gaps. The scope of investigative works shall be agreed with the Local Authority Environmental Health Officer and NRW and permission sought from the Coal Authority, where required;
- Completion of detailed quantitative risk assessment for controlled waters for the areas of Proposed Development to establish if unacceptable risks are present;
- Completion of ground gas risk assessment using monitoring data to identify the Characteristic Situation and to determine the potential requirement for gas protection measures within properties;
- Review of identified residual soil contamination against the defined masterplan and finished ground levels to determine the relevant proposed end uses and whether residual contamination coincides with areas of cut or fill;
- Where exceedances of SAC indicate the presence of potentially unacceptable risks, remediation in the form of hotspot removal and/or installation of vapour membranes may be required, followed by suitable verification;
- Confirmation of the requirement (or otherwise) for radon protection measures in residential properties at the Site;
- Review of geotechnical data to determine the engineering properties of the ground and identify ground stability or ground engineering constraints which need to be considered in the design of the Proposed Development.



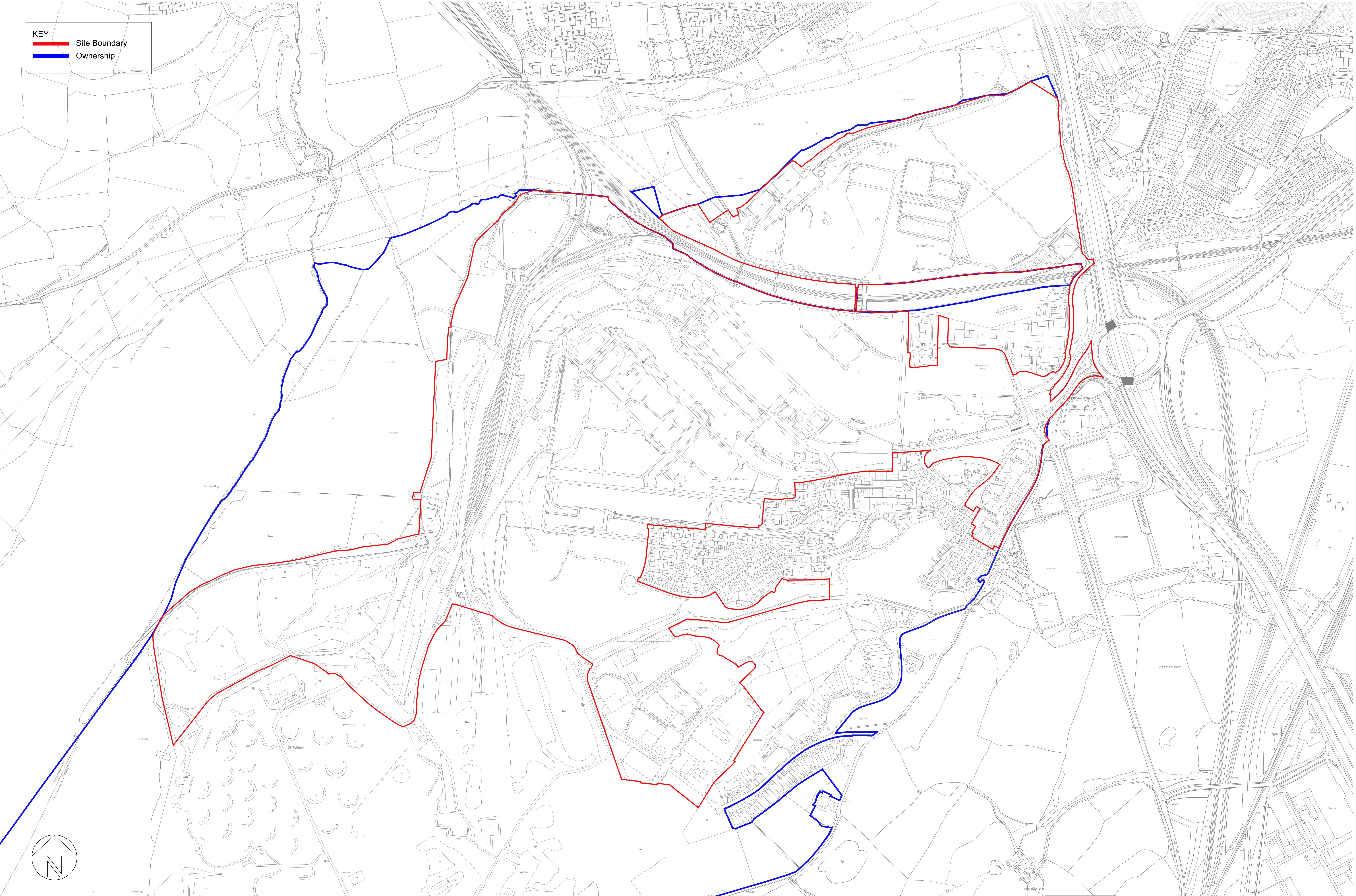
10 References

- Envirocheck Report 283848248_1_1, Landmark, 20 August 2021
- Geoindex <https://mapapps2.bgs.ac.uk/geoindex/home.html>, British Geological Survey, Accessed August 2021
- Flood Map for Planning Environment Agency, https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/Flood_Risk/viewers/Flood_Risk/virtualdirectory/Resources/Config/Default&layerTheme=0 Accessed August 2021
- Explosive Ordnance Threat Assessment, BACTEC, 16 January 2009
- Coal Mining Report 51002684979001, The Coal Authority, 29 September 2021
- Coal Mining Risk Assessment 05474-OUT-006, PJA, November 2021
- BP Llandarcy Refinery Desk Study 44382742/BRRP0001, URS, July 2007
- DiMe Area Controlled Waters Risk Assessment, 5041216-REM-RPT-000372, Atkins, August 2010
- Monitor Phase 20 Validation Report 5041216-REM-RPT-000819, Atkins, September 2012
- Monitor Phase 22 Validation Report 5041216-REM-RPT-000818, Atkins, March 2013
- Commercial Area Monitor Phase 28 Validation Report 5041216-PLOTS-RPT-001016, Atkins, May 2015
- Monitor Phase 29 Validation Report 5041216-PH2D-RPT-0001139, Atkins, October 2014
- Monitor Phase 30 Validation Report 5041216-PLOTS-RPT-1017, Atkins, October 2014
- Monitor Phase 31 Validation Report 5041216-PLOTS-RPT-1284, Atkins, January 2015
- Monitor Phase 32 Validation Report 5041216-REM-RPT-0001408, Atkins, October 2015
- Monitor Phase 33 Validation Report 5041216-OSW-RPT-0001393, Atkins, October 2015
- Monitor Phase 39 Validation Report 5041216-PLOTS-RPT-0001340, Atkins, October 2015
- Monitor Phase 43 Validation Report 5041216-PLOTS-RPT-0001405, Atkins, October 2015
- Monitor Phase 53 Validation Report 5041216-REM-RPT-0001332, Atkins, September 2015
- Monitor Phase 54 Validation Report 5041216-REM-RPT-0001345, Atkins, October 2015
- Monitor Phase 57 Validation Report 5041216-OSW-RPT-0001407, Atkins, October 2015
- Monitor Phase 58 Validation Report 5041216-OSW-RPT-0001385, Atkins, October 2015
- Monitor Phase 68 Validation Report 5041216-OSW-RPT-0001404, Atkins, October 2015
- Monitor Phase 69 Validation Report 5041216-OSW-RPT-0001396, Atkins, October 2015
- Monitor Phase 70 Validation Report 5041216-OSW-RPT-0001394, Atkins, October 2015



- Monitor Phase 72 Validation Report, 04020-PJA-21-XX-RP-R-0053, PJA, June 2021
- Crymlyn Tip Data Review, PJA, January 2021
- Mine working investigation 5041216-REM-TN-0336, Atkins, June 2010
- Investigation of recorded mine entries on upper terrace 5041216-REM-TN-000494, Atkins, January 2011
- Geo-Environmental Assessment and Outline Remediation Strategy Proposed Persimmon Plot and Upper and Middle Terraces 5041216-REM-RPT-000645, Atkins, August 2011
- Land contamination risk management (LCRM), Environment Agency, 2020
- C552 Contaminated Land Risk Assessment. A Guide to Good Practice, CIRIA, 2001
- Coed Darcy Section 106 Agreement RAP Works Schedule 7, 2008
- RAP Works Completion Reports, Atkins/URS

Appendix A Drawings



KEY

DEVELOPMENT

1. New three-form entry primary school with potential for sports facilities managed for wider community use.
2. Potential local centre uses (with residential use above).
3. Higher density housing along main spine road forming gateway into the site.
4. Medium density housing to form body of site.
5. Low density housing in more sensitive areas (to benefit amenity of adjoining residents and around landscape edges).
6. Landmark buildings with flexibly designed ground floor for potential commercial use dependent on demand and residential use above.
7. Potential extra care / mixed use residential.
8. Additional Commercial units extension to Coed Darcy Business Park

ACCESS

9. Primary vehicle access via Ffordd Coed Darcy onto the B4290
10. Secondary vehicle access to the Northern parcel from the B4290
11. Pedestrian / Cycle footbridge over the railway line
12. Tree-lined main spine road.
13. Network of new paths and trim trails to encourage informal recreation, including around residential edges.
14. Pedestrian/cycle access connection to Skewen.
15. Pedestrian/cycle access connection to Tank Farm Road
16. Pedestrian/cycle access connection to Llandarcy.
17. Potential pedestrian/cycle access connection to Jersey Marine (subject to funding)
18. Potential pedestrian/cycle access connection to Heol Crymlyn (subject to funding)
19. Tree-lined secondary green street.
20. Off road cycle route

LANDSCAPE

21. Retained / enhanced areas of woodland
22. Ancient woodland retained
23. New areas of woodland creating continuous buffer
24. Existing hedgrow retained / enhanced.
25. Landscaped bund
26. Attenuation basin surrounded by new and retained planting
27. Community civic space at the centre of the development containing retaining 'Amphitheatre' feature.
28. Incidental public open space responding to Neighbourhood needs
29. Retained prominent rockface.
30. Terraced plateaux with the opportunity for mini ecology areas for biodiversity and educational benefit
31. Natural play opportunities within wider landscape
32. New planting and retained hedgerow
33. Accessible central park alongside sports pitches

ECOLOGY

34. Green Infrastructure design lead by delivering ecological connectivity, including across the wider Coed Darcy site and wider landscape
35. Extensive western green buffer to function as dispersal corridor for faunal species
36. Creation of dedicated ecology areas with no public access.
37. Open space to deliver extensive early successional habitat with floristically rich dry grasslands
38. Significant topographical diversity to be designed into semi-natural greenspace to maximise micro-habitat diversity
39. Network of wetland habitats to provide optimal amphibian habitat
40. Integrated ecological features within main development footprint to include living roof habitat, nesting and roosting boxes.



This drawing must not be scaled.
Figured dimensions and levels to be used.
Any inaccuracies must be notified to the architect.
Detail drawings and large scale drawings take precedence over smaller drawings.

Rev: D Red line updated: RF 18 11 2021

Chk'd: Rev:

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PRELIMINARY	✓
PLANNING	
DESIGN	
TENDER	
CONSTRUCTION	

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Contract: Coed Darcy Masterplan

Title: Illustrative Masterplan

Drawing No. 21009(05) 104 Rev. D

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