

Glan Llyn
Phase 4B & 5D
Remediation Strategy

Glan Llyn, Newport Phase 4B & 5D

Remediation Strategy

For

Revantage Real Estate

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Approval Status	Name & Position
Prepared by:	Aimee Meredith-Smith BSc (Hons) MScR Graduate Geo-Environmental Consultant
Reviewed by:	Florence Trahair BSc (Hons) FGS Senior Geo-Environmental Consultant
Approved by:	Chris Wilson BSc (Hons) MCIWEM Principal Geo-Environmental Consultant

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1.0 Introduction

1.1. Terms of Reference

Phase 4B & 5D of the Glan Llyn development in Newport (hereafter referred to as the 'Site') is situated within the ongoing redevelopment of the former Llanwern Steelworks. The site location plan is included in **Appendix A**.

The eastern part of Phase 4B & 5D formed part of a separate contract managed by Vertase FLI and was approved under planning application references 23/1127 (PC27) and 24/0468 (PC28). This area is not included in this Remediation Strategy.

In July 2024 the Client, St Modwen Developments were rebranded to be called Revantage Real Estate. Any reference to the previous company name in this report should be referred to accordingly.

A contractor shall be employed by Revantage Real Estate to undertake the ground preparation and remediation works, to include the requirements of this strategy. A monitoring engineer will oversee the works to monitor that the requirements of this strategy are achieved.

1.2. Purpose

This report has been prepared pursuant to the discharge of Planning Condition 27 of the Outline Planning Permission Reference 06/0471 for the proposed development of residential development Phase 4B & 5D as part of a wider mixed-use development at Llanwern, Newport.

Planning Condition 27 states the following:

“(27) Prior to the commencement of each phase of development as defined by Condition 03 (or at such other date or stage in development or for such specified activities or works as may be agreed in writing with the Local Planning Authority), the following components of a scheme to deal with the risks associated with contamination relating to that phase or activity shall each be submitted to and approved, in writing, by the Local Planning Authority:

- (1) A preliminary risk assessment which has identified:*
 - (a) all previous uses;*
 - (b) potential contaminants associated with those uses;*
 - (c) a conceptual model of the site indicating sources, pathways and receptors;*
 - (d) potentially unacceptable risks arising from contamination at the site.*

(2) A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site.

(3) The site investigation results and the detailed risk assessment (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.

(4) A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in (3) are complete and identifying any requirements for longer term monitoring of pollutant linkages, maintenance and arrangements for contingency action. Any changes to these components require the express consent of the Local Planning Authority.

Reason: To ensure that the proposed development will not cause pollution of the environment or harm to human health."

The scope of this report is detailed in Section 1.3 below. It is considered that this report addresses the requirements of Condition 27 part 3 and part 4. Part 1 and part 2 has been addressed in the Phase 4B & 5D Desk Study & Ground Investigation Report (document reference 18669-RLL-22-XX-RP-O-0328-P03, dated June 2025).

1.3. Objectives

The objective of this document is to specify both the remediation and validation works required to facilitate the proposed development and mitigate identified potential risks to human health. The remediation works will also seek to mitigate previously unidentified risks to human health, should they be encountered.

The potential risks associated with controlled waters shall be managed in accordance with the Soils Validation Strategy for Protection of Controlled Waters and validated in a forthcoming Controlled Waters Validation report by H F Consulting Ltd (HFCL). The primary focus of the remediation works is decreasing the infiltration through Made Ground by way of the re-engineering limiting mobilisation of leachable contaminants to the surface waters. The remediation will comprise the excavation of buried obstructions and removal of contamination identified from previous phases of ground investigation and during the remedial turnover. Material is to be turned over and placed with an onward verification sampling programme to assess compliance with the remediation criteria established within this document for the Site.

Remedial requirements for the onward developer are detailed in Section 6.8.

1.4. Reference Reports

The following documents and data sources have been reviewed in preparation of this document and should be read in conjunction with this report:

- RLL, Phase 4B & 5D Desk Study and Ground Investigation Report, ref. 18669-RLE-22-XX-RP-O-0328-P03, dated June 2025.
- RLL, Updated Controlled Waters Detailed Quantitative Risk Assessment, Glan Llyn, ref. 18669-RLE-19-RP-O-0006, dated June 2022.
- RLL, Phase 4B & 5D Controlled Waters Detailed Quantitative Risk Assessment Addendum ref. 18669-RLL-24-XX-RP-O-0591-P03, dated September 2025.
- H Fraser Consulting (HFCL), Glan Llyn: Soils Validation Strategy for Protection of Controlled Waters December 2024.

1.5. Limitations and Confidentiality

All conclusions and recommendations made within this report are based on and limited to the factual information. No responsibility can be taken by RLL for information obtained by third parties and it has been assumed that all third-party information provided is true and correct.

No liability can be accepted for conditions not revealed within the exploratory holes or pits undertaken. The exploratory points cover only a small portion of the total Site area. RLL has, where necessary, undertaken extrapolation between locations and no responsibility can be taken for different conditions which may occur between locations.

RLL has undertaken the work in accordance with our understanding of current best practice at the time of undertaking the report. Further assessment and revision of the report may be required should new information come to light or legislation/ changes to best practice be introduced after the date of issue of the report. RLL has prepared the report for the sole use and reliance of the Client. The report may not be used or relied upon by any unauthorised third party without the explicit written agreement of RLL.

The work undertaken within this report remains the intellectual property of RLL and must not be divulged to any commercial third party without the prior written agreement of RLL.

2.0 Background Information

2.1. Proposed Development

It is understood that the Site is proposed to be redeveloped for a residential end-use. An illustrative masterplan (ref. 8111-08-A011, dated April 2019) is available in **Appendix A**.

The development will form part of the wider Glan Llyn development.

2.2. Site Description

The Site is located within the Glan Llyn development at the former Llanwern Steelworks, approximately 4km to the east of Newport City Centre at approximate National Grid Reference 335990E, 186950N. The wider Glan Llyn development covers approximately 250 hectares and is proposed to be redeveloped for residential, commercial, and public open space use.

The Site is irregular in shape, covers an area of approximately 3.10ha, and is located in the approximate centre of the wider Glan Llyn development. The Site historically housed a bag filter plant, conveyors, hoppers and a travelling boom.

The Site boundary is shown on drawing 18669-RLL-22-XX-DR-O-0323-P02, **Appendix A**.

2.3. Site History

A detailed assessment of historical maps is provided within the RLL Desk Study & Ground Investigation Report (18669-RLE-22-XX-RP-O-0328-P03), with a brief summary provided below.

Historically, the Site is shown to comprise agricultural land with approximately three structures associated with Decoy Pool Farm in the north and part of Decoy Pool (marshy pond) which was surrounded by deciduous woodland and an orchard in the north east.

Previous infrastructure was demolished by 1967 when the Site formed part of Llanwern Steelworks, and comprised a conveyor network with associated travelling boom and hoppers and a bag filter plant. The Site was partially demolished by 2006 and completely demolished to slab level by 2009.

2.4. Geology

Information pertaining to underlying ground conditions has been obtained via the British Geological Survey's (BGS) Onshore Geoindex¹.

The published geological information shows the Site to be void of Made Ground. However, due to the Site's history, Made Ground is likely to be present associated with the previous development and subsequent demolition.

Superficial deposits are shown to comprise Tidal Flat Deposits.

Tidal Flat Deposits are described by the BGS as *'unconsolidated sediment, mainly mud and/ or sand. They may form the top surface of a deltaic deposit. Normally a consolidated soft silty clay, with layers of sand, gravel and peat.'*

The underlying bedrock is shown to be the Mercia Mudstone Group.

The Mercia Mudstone Group is described by the BGS as comprising *'predominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite bearing units in some basinal areas. Thin beds of gypsum/anhydrite are widespread; sandstones are also present'*.

There is a fault approximately 500m north-east of the Site which trends roughly north to south and extends northwards away from Site.

2.5. Hydrogeology

The Mercia Mudstone Group strata is defined as a Secondary B Aquifer and the superficial Tidal Flat Deposits are defined as Unproductive Strata.

Secondary B Aquifers are classified as comprising *'predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifer'*.

Unproductive Strata classification has been given to cases where *'rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow'*.

¹ <http://mapapps2.bgs.ac.uk/geoindex/home.html>

2.6. Hydrology and Flooding

	Summary
Surface Water features	On-Site: No records of surface water features within Phase 4B & 5D. Off-Site: The Site is located within a privately drained system. The nearest surface watercourse, within the private system, on completion of the development is proposed to be a lake adjacent to the south and Ellen's Reen, approximately 100m northwest. Monk's Ditch is located approximately 500m east of the Site, it is a primary inland river of the Usk and Llwyd catchment. Monks Ditch is canalised in a concrete channel and flows south beneath the Queensway, it is proposed that the future surface water network of reens and lakes in Glan Llyn will discharge via a pumping system into Monk's Ditch. The River Usk is located approximately 3.4km to the west and the Severn Estuary is located approximately 5.0km to the south.
Surface Water Abstractions	No active water abstraction records within 500m.
Flood Risk	The Site lies within an area shown as having a Low Flood Risk from Sea according to Natural Wales Flood Risk mapping from Natural Resources Wales.

2.7. Radon

A Radon Risk Address Search was undertaken and issued by the British Geological Survey, dated November 2022 (Report ID: BGS_329111/39194), which stated that the Site does not lie within a radon affected area and 'no radon protective measures are required for the report area'. A radon affected area is defined as: 'where less than 1% of homes are estimated to be at or above the action level'.

As such, the probability of the Site being above the Action Level for radon is 0-1%.

3.0 Ground Investigations and Surveys

3.1. Existing Reports

One phase of ground investigation has been undertaken within the current Site boundary, as summarised in the following table.

Summary of Historical Exploratory Holes within the Site Boundary	
Report	Exploratory Holes
RLL (2021)	35 Trial Pits (U14, U12, T14, S15, S14, R18, R15, R14, Q17, Q14, P16, P15, P14, V21, V20, V19, V18, V17, V16, V14, V13, V12, V11, V10, U19, U16, U15, U11, U10, T18, T15, T13, T12, T10 and S16)

Drawing 18669-RLL-22-XX-DR-O-0327-P02 presented in Appendix A shows the location of the exploratory holes.

3.2. Geological Summary

The Site was found to be underlain by Made Ground overlying superficial deposits, comprising Tidal Flat Deposits and bedrock strata of the Mercia Mudstone Group.

3.3. Made Ground – Reworked Topsoil

Made Ground of reworked topsoil was encountered overlying general Made Ground in three locations (TP-Q14, TP-R15 and TP-U11), from ground level to depths of between 0.10-0.50m, comprising brown to dark brown occasionally loamy CLAY or soft brown sandy gravelly TOPSOIL with rootlets.

3.4. Made Ground – Surfacing

Surfacing of asphalt was encountered in one location (TP-V18) from ground level to 0.20m.

3.5. Made Ground - General

Made Ground was encountered in all 35 exploratory holes from ground level or underlying the surfacing/ reworked topsoil at thicknesses of between 0.50m to 3.10m and was generally described as:

- Reddish brown to brown sandy gravelly CLAY, with occasional cobbles;
- Brown sandy GRAVEL, with occasional cobbles;
- Orangish brown, reddish brown, black to grey, or white (occasionally clayey and sandy) GRAVEL of slag or fused slag;
- Black, grey or white SAND of slag, (occasionally gravelly or cobbly);
- Bluish grey or greyish black FUSED SLAG;

- Brownish green clayey SAND; and
- Black SAND of slag and/ or coal.

Gravel and cobble constituents typically comprised sandstone, mudstone, shale, concrete, brick, and slag, as well as occasional fragments of plastic, timber, iron ore and metal.

Visual and olfactory evidence of contamination are discussed in Section 3.9.

Buried obstructions and services are discussed in Section 3.10.

3.6. Superficial Deposits

Tidal Flat Deposits were encountered beneath the Made Ground in 14 locations (TP-P14, TP-P15, TP-Q14, TP-R18, TP-S14, TP-S15, TP-S16, TP-T13, TP-T14, TP-T15, TP-U11, TP-U12, TP-U16 and TP-V16). The top of the strata was encountered underlying the Made Ground at depths of 1.20 - 2.30m. The base of the formation was not encountered but the strata was recorded to a maximum depth of 2.60m. It generally comprised very soft to firm bluish grey to occasionally grey mottled black occasionally peaty CLAY.

3.7. Bedrock

The Mercia Mudstone Group bedrock was not encountered during the intrusive investigation of Phase 4B & 5D.

3.8. Encountered Groundwater

During the intrusive investigation, perched water was encountered in 24 locations, typically perched within the Made Ground, or towards the base of the Made Ground perched on top of the natural clay. The depth below ground level was recorded from 0.60m to 2.10m.

3.9. Visual and Olfactory Evidence from Previous Ground Investigations

During the intrusive investigation, visual or olfactory evidence of contamination was encountered in nine locations as detailed in the following table.

Visual / Olfactory Evidence of Contamination			
Exploratory Hole	Depth (m)	Strata*	Remarks
TP-T13	0.60-0.70	MG	Sulphur odour
TP-T14	0.20-0.30	MG	Sulphur odour
TP-U12	1.80-2.00	MG	Sulphurous odour and slight hydrocarbon stain
TP-U14	0.75-0.90	MG	Water had sulphurous odour
TP-U16	0.75-0.90	MG	Water had hydrocarbon sheen and odour
	1.20-1.80	MG	Slight hydrocarbon staining

Visual / Olfactory Evidence of Contamination			
Exploratory Hole	Depth (m)	Strata*	Remarks
TP-V10	1.40-1.50	MG	Water has slight biofilm and slight hydrocarbon sheen
TP-V11	0.50-1.90	MG	Sulphurous odour
TP-V12	1.30-1.60	MG	Hydrocarbon odour
TP-V16	1.40-1.50	MG	Water has slight hydrocarbon sheen

Notes: *MG= Made Ground

3.10. Buried Obstructions

Buried obstructions or services were encountered in eleven exploratory locations as detailed in the following table.

Encountered Buried Obstructions			
Borehole	Depth (m)	Strata*	Remarks
TP-R15	1.40-1.50**	MG	Fused slag
TP-R18	0.60-2.50**	MG/TFD	Pile in west of pit
TP-T10	3.00-3.10**	MG	Concrete obstructions
TP-T12	0.50-0.60**	MG	Hard fused slag
TP-U10	1.70-1.90**	MG	Concrete structure and hard fused slag
TP-U15	1.10**	MG	Concrete slab
TP-V13	1.00-1.20**	MG	Rebar, fused slag and potential concrete slab
TP-V14	1.10-1.20**	MG	Fused slag
TP-V17	0.20-0.30	MG	Asphalt
TP-V19	0.30-0.40	MG	Asphalt
TP-V20	0.50-0.60	MG	Asphalt

Notes: *MG= Made Ground, TFD= Tidal Flat Deposits; **base of obstruction not encountered.

3.11. Perched Water

During the intrusive investigation, perched water was encountered in 24 locations, typically within the Made Ground, or towards the base of the Made Ground on top of the natural clay. The depth below ground level was recorded from 0.60m to 2.10m.

3.12. Ground Gas Monitoring

No gas monitoring was undertaken during the RLL 2021 ground investigation. A programme of shallow gas monitoring is recommended following any turnover and earthworks reengineering.

The classification of the Site will depend on the competency of the upper clay of the Tidal Flat Deposits. A site-specific ground gas assessment is recommended following the completion of the earthworks.

3.13. Contamination Summary

During the 2021 RLL ground investigation, 60 samples were tested for heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), gasoline range organics (GROs), BTEX, pH, soil organic matter (SOM), cyanide, phenols, ammoniacal nitrogen and select samples were also tested for asbestos.

The samples collected were conservatively assessed against LQM/ CIEH 2015 S4ULs (Suitable for Use Levels) for a residential end use with plant uptake (1% SOM). A summary of exceedances is presented in the following table, and the chemical analysis results are presented in full in the Desk Study and Phase 2 Report (18669-RLL-22-XX-RP-O-0328-P03).

Summary of Exceedances of S4ULs Residential with Plant Uptake Criteria.				
Contaminant	No. of Exceedances	Location of Exceedances (Depth in m)	Concentration Range (mg/kg)	Screening Value (mg/kg)
Arsenic	1 of 60	P16-1 (0.30)	78.6	37
Lead	2 of 60	V11-1 (0.50), V16-2 (1.80)	400 - 408	200
Mercury	1 of 60	Q14-1	2.13	1.2
Vanadium	8 of 60	P14-2 (1.80), P15-1 (0.30), P15-2 (2.20), P16-1 (0.30), P16-2 (1.30), Q17-1 (0.30), Q17-2 (1.50), V11-1 (0.50)	413 - 680	410
Aromatics > EC12-EC16	1 of 60	T10-3 (2.90)	151	140
Aromatics > EC16-EC21	1 of 60	T10-3 (2.90)	265	260
Naphthalene	2 of 60	Q14-1 (0.50), Q17-1 (0.30)	20.5 – 24.1	15
Benz(a)anthracene	3 of 60	Q14-1 (0.50), Q17-2 (1.50), T10-1 (0.30)	14.9 – 20.3	7.2
Chrysene	1 of 60	Q17-2	16.9	15
Benzo(b)fluoranthene	10 of 60	P15-2 (2.20), Q14-1 (0.50), Q17-2 (1.50), R15-2 (1.20), T10-1 (0.30), T10-2 (1.00), U10-1 (1.00), U16-1 (1.00), U16-2 (2.00), V10-1 (0.30)	2.62 – 20.8	2.6
Benzo(a)pyrene	8 of 60	P15-2 (2.20), Q14-1 (0.50), Q17-1 (0.30), Q17-2 (1.50), R15-2 (1.20), T10-1 (0.30), T10-2 (1.00), V10-1 (0.30)	2.28 - 15.3	2.2
Dibenzo(a,h)anthracene	15 of 60	P15-2 (2.20), Q14-1 (0.50), Q17-1 (0.30), Q17-2 (1.50), R15-2 (1.20), T10-1 (0.30), T10-2 (1.00), U10-1 (1.00), U12-1 (0.60), U16-1 (1.00), U16-2 (2.00), V10-1 (0.30), V10-2 (0.30), V11-1 (0.50), V11-2 (1.60)	0.25 – 2.12	0.24
Benzene	60 of 60	All Samples	<0.18 - <1.80	0.087

60 of 60 samples were shown to exceed the screening criteria for benzene. It should be noted that only one sample (S16-1 0.90m) had a concentration above the limit of detection for benzene. The detection limit for benzene tested listed by the

laboratory was between 0.18mg/kg (53 samples) or 1.8mg/kg (7 samples), these are greater than the screening value of 0.087mg/kg and causes a significant skew in the results. Where samples are reported at the detection limit, for screening purposes, it has been conservatively assumed that the value is 0.18mg/kg or 1.8mg/kg. The true concentration is likely to be significantly lower than this value.

The intention is to validate the suitability of the earthworks in relation to controlled waters using H Fraser Consulting soil re-use values (SRVs), presented within the H Fraser Consulting Soils Validation Strategy (30937 R2, **Appendix E**). A summary of the exceedances is presented in the following table, full screening is presented in **Appendix B**.

Summary of Exceedances of HFC Soil Re-Use Values:				
Contaminant	No. of Exceedances	Location of Exceedances (Depth in m)	Concentration Range (mg/kg)	Screening Value (mg/kg)
Cyanide (total)	7 of 60	P14-2 (1.80), Q14-1 (0.50), Q17-1 (0.30), U16-1 (1.00), V12-2 (1.60), V18-1 (0.50)	2.35 – 20.90	2.02
Manganese	2 of 60	P15-2 (2.20), P16-1 (0.30)	34400.00 – 93900.00	33300.00
Phenanthrene	2 of 60	Q17-2 (1.50), T10-1 (0.30)	44.3 – 60.80	27.00
Fluoranthene	6 of 60	P15-2 (2.20), Q14-1 (0.50), Q17-2 (1.50), R15-2 (1.20), T10-1 (0.30), T10-3 (2.90)	7.75 – 58.30	6.64
Benzo(b)fluoranthene	7 of 60	P15-2 (2.20), Q14-1 (0.50), Q17-2 (1.50), R15-2 (1.20), T10-1 (0.30), T10-2 (1.00), U16-1 (1.00)	3.44 – 208.00	3.42
Benzo(k)fluoranthene	3 of 60	Q14-1 (0.50), Q17-2 (1.50), T10-1 (0.30)	5.66 – 7.62	5.05

More detailed information including the calculated reuse criteria is available in the Hannah Fraser Consulting Soils Validation Strategy (30937 R2, **Appendix E**).

Asbestos was identified in five samples from the 30 analysed; a summary of the asbestos identified is given in the below table.

Summary of Asbestos Identified within the Site		
Location (Depth in m)	Asbestos Type	Quantification (%)
P15-1 (0.30)	Amosite (Brown) Asbestos	<0.001
R14-1 (0.10)	Chrysotile (White) Asbestos	<0.001
S14-1 (0.50)	Chrysotile (White) Asbestos	<0.001
T10-1 (0.30)	Chrysotile (White) Asbestos	<0.001
U15-1 (1.00)	Chrysotile (White) Asbestos	0.0039

Asbestos was identified in five samples of the 30 tested; all positive samples were tested to ascertain the amount of asbestos tested and returned results of <0.001%

to 0.0039%. The Institute of Occupational Medicine (IOM) risk assessment report for the reuse of soils containing asbestos at Llanwern (Ref. 401134-IOM-14-XX-RP-Z-0001) states that a minimum of 0.6m of clean soil (asbestos content <0.001%) will be placed across the Llanwern site. Soil will be screened and, if asbestos contamination is less than 0.02% (200PPM) in the soil, that soil may be used in residential areas.

No groundwater samples have been taken from within the Site, however, samples taken from the wider development as part of previous investigations have identified elevated concentrations of contamination in line with the historical site usage. Elevated concentrations of contamination within on-Site soils also have the potential to leach and migrated into groundwater. A potential risk to Controlled Waters may therefore exist.

4.0 Conceptual Site Model

4.1. Potential Pollutant Linkages

This section provides a qualitative assessment of the risks posed from on-Site contamination sources identified from the information presented in the previous sections. The Conceptual Site Model (CSM) considers the findings of both the ground investigations/ surveys that have been undertaken at the Site and the Site's history. The CSM is based on current conditions at the Site and makes recommendations for likely remediation and mitigation measures that may be required.

The assessment carried out assumes that the Site will operate as a residential development comprising houses with gardens, therefore a 'residential end use with plant uptake' scenario has been used as the most conservative approach. Should the end-use be altered, potential pathways and receptors should be re-assessed.

The CSM below has been developed based on the commonly adopted source-pathway-receptor model as recommended within the Environment Agency's Land Contamination Risk Management (LCRM, updated from CLR11 'Model Procedures for the Management of Land Contamination') guidance.

4.2. Source

The Site makes up part of the former Llanwern Steelworks; the Site historically comprised a conveyor network with associated travelling boom and hoppers and a bag filter plant.

60 soil samples were collected during the RLL 2021 ground investigation for contamination testing, all of which were taken from the Made Ground.

Chemical analysis of soil samples has identified concentrations higher than Residential with Plant Uptake S4ULs for arsenic, lead, vanadium, mercury, aromatics >EC12-EC16, aromatics >EC16-EC21, benzene and a number of PAHs.

Chemical analysis of soil samples has identified concentrations higher than the agreed soil re-use values (SRVs) for cyanide, manganese, phenanthrene, fluoranthene, benzo(b)fluoranthene, and benzo(k)fluoranthene.

Asbestos was identified within five of the 30 soil samples tested in the form of debris to loose fibres at concentrations of <0.001% to 0.0039%.

Potential contaminant sources are summarised in the following table.

Summary of Identified On Site Sources of Contamination		
Source	Site Area	Key Contaminants
Deep Made Ground, including slag material	Whole Site	Heavy metals, PAHs, cyanide
Historical Steelworks infrastructure	Whole Site	Heavy metals, PAHs, cyanide
Made Ground	Isolated locations across the Site	Low concentrations of asbestos.
Natural Strata	Whole Site	Potential for ground gas from organic materials in the Tidal Flat Deposits

4.3. Potential Pathways

Human Health

There is potential for exposure of Site users (future and proposed) to contaminants in soils via the following pathways, assuming a residential end use (based on the Environment Agency's *Updated Technical Background to the CLEA Model - SR3*):

- Direct soil and dust ingestion;
- Dermal contact with soil directly and indoor dust;
- Plant uptake followed by consumption of homegrown produce;
- Inhalation of vapours;
- Inhalation of dust; and
- Inhalation of gases.

The presence of contamination within the Site presents a potential risk to construction workers within the Site boundary, as such appropriate risk assessments and safety measures (use of PPE/ hygiene rules) will need to be enforced in order to provide adequate protection.

Controlled Waters

Currently Monk's Ditch crosses the wider development within a concrete channel and no connection with the private drainage system presently exists. It is proposed that the future surface water network of reens and lakes will discharge via a pumping system into Monk's Ditch. This on-site surface water system will discharge, via a permit, into Monk's Ditch once the specified quality criteria are met and the application to connect the system is approved.

As such, Monk's Ditch currently isn't a Receptor (it is understood to be hydraulically isolated as it flows between the Glan Llyn development and commercial land to the east within a concrete channel) although it could potentially be a future Receptor when the surface water discharge permit into the Monks Ditch is approved and then enacted.

Site monitoring of areas of site where earthworks have been undertaken show that the re-engineered Made Ground will be unlikely to enable a continuous groundwater

horizon to exist. It is therefore considered unlikely that any significant groundwater flow will develop within the Made Ground.

With regard to controlled waters, the following pathways are considered applicable to the Site, following completion of the development and once relevant approvals have been granted to allow discharge into Monks Ditch:

- Leaching of soil-borne contamination in Made Ground and subsequent lateral migration through permeable pathways in Made Ground to Monks' Ditch via onsite reens.

No effective pathway was identified between the shallow perched water in the Made Ground and the deep groundwater within the Mercia Mudstone Secondary B Aquifer due to the low permeability of the clay-rich Tidal Flat Deposits.

Details relating to the Controlled Waters Risk Assessment are summarised in Section 5.0.

Structures

Concrete classification testing has not been undertaken. A Design Sulphate (DS) class and Aggressive Chemical Environment for Concrete (ACEC) class should be derived for the Site in accordance with the recommendations given within BRE SD1 and based on pH and sulphate testing.

Dependent on finished levels, it is considered likely that chemical resistant barrier pipes will be required.

A site-specific ground gas assessment is recommended following the earthworks. The classification of the Site will depend on the competency of the upper clay of the Tidal Flat Deposits.

4.4. Potential Receptors

The following receptors (current and proposed) have been identified at the Site. Given the absence of significant ecological designations in the vicinity of the Site, ecological receptors are not considered below.

Humans:

- Construction workers and maintenance workers; and
- Residents on and off-site (current and future).

Controlled Waters:

- Mercia Mudstone Group (Secondary B Aquifer) and Tidal Flat Deposits (Secondary [Undifferentiated] Aquifer); and

- Monk's Ditch (once relevant approvals have been granted to allow discharge into Monk's Ditch).

Private Drainage System:

- The nearest proposed water feature comprises the private drainage reens located 50m to the northwest (Ellens Reen) and lake adjacent to the south of the Site.

Property:

- Existing and proposed buildings and services on and immediately surrounding the Site; and
- Proposed infrastructure on the Site.

4.5. Conceptual Site Model and Risk Assessment

Based on the information currently available, plausible pollutant linkages have been identified and a risk assessment has been undertaken for the Site. The estimation of the potential significance of each linkage is based on the proposed Site redevelopment, the mobility and the predicted magnitude of potential contaminants, and the nature of the identified migration/exposure pathways.

4.6. Summary of Conceptual Site Model

The following table presents what are considered to be potential receptors for contamination both pre- and post- remediation. Should the end-use be altered, potential pathways and receptors should be re-assessed.

Summary of Pre-Remediation and Post Remediation Conceptual Site Model (CSM) for Phase 4B & 5D										
Sources	Key Contaminants	Receptor	Pathway	Pre-Remediation			Post-Remediation			
				Probability	Consequence	Risk Level	Mitigation	Probability	Consequence	Risk Level
Made Ground Contaminants within soil and generation of gases.	Inorganic substances (heavy metals/ asbestos)	Human Health:	Direct Contact – dermal contact, absorption through skin, ingestion. Inhalation of vapours (VOCs) from soil derived gas via Made Ground.				During construction, appropriate PPE should be worn when coming into contact with arisings.			
		Construction Workers End Users (on and off site)	Potential migration and build-up of carbon dioxide from soils derived gas via Made Ground (risk of asphyxiation). Inhalation of contaminants in soils/dust/fibres.	Moderate	Medium	Moderate	With the installation of a clean cover system the pathway of contaminants within the underlying soil to reach human health receptors is essentially severed. Additional post-remedial ground gas/ vapour assessment is required.	Low	Medium	Low
	Organic substances (ammoniacal nitrogen, petroleum hydrocarbons, PAHs, VOCs, SVOCs)	Property:	Direct contact – contaminants in soils, soil derived dust, perched water and groundwater.	Moderate	Medium	Moderate	Additional post-remedial ground gas/ vapour assessment is required. Design of concrete in accordance with BRE Special Digest 1.	Low	Medium	Low
			Concrete in contact with aggressive ground.				Dependent on finished levels, it is likely that chemical resistant barrier pipes will be required.			
		Future on Site Buildings Future on Site Infrastructure	Potential migration and build-up of methane from soil derived gas via Made Ground (risk of explosion).	Moderate	Medium	Moderate	Additional post-remedial ground gas/ vapour assessment is required to further assess the Site.	Low	Medium	Moderate
		Controlled Waters:	Potential migration of leachable contaminants	Moderate	Medium	Moderate	Analysis of the groundwater data to validate the conclusions of the Controlled Waters	Low	Medium	Low to Moderate

Summary of Pre-Remediation and Post Remediation Conceptual Site Model (CSM) for Phase 4B & 5D										
Sources	Key Contaminants	Receptor	Pathway	Pre-Remediation			Post-Remediation			
				Probability	Consequence	Risk Level	Mitigation	Probability	Consequence	Risk Level
		Secondary B Aquifer Private Drainage System: Ellen Reen	through shallow groundwater.				Risk Assessment which has shown the leachable effect of the Made Ground on the controlled waters receptors is acceptable. The proposed remediation and onward redevelopment will reduce infiltration in an overall betterment of the Site.			
		Flora and Fauna	Uptake through roots of contaminants in soils.	Low	Medium	Low	Importation of suitable topsoil material for use within garden areas and landscaped areas.	Unlikely	Medium	Low
Residual contaminants in groundwater	Inorganic substances (heavy metals) Organic substances (ammoniacal nitrogen, petroleum hydrocarbons, PAHs, VOCs, SVOCs)	Human health: Construction Workers End Users	Direct contact – dermal contact, absorption through skin, ingestion. Inhalation of vapours (VOCs) from soil derived gas via Made Ground.	Moderate	Medium	Moderate	Appropriate PPE should be worn when coming into contact with perched water. Should potentially contaminated perched water be encountered during site works, it should be contained and disposed of off-site at a suitably permitted facility. Due to the depth of the groundwater and with the installation of clean cover, it is unlikely that residential end users will come into contact with it, therefore no viable pathway is present. Vapour resistant membranes may be required following a	Low	Medium	Low to Moderate

Summary of Pre-Remediation and Post Remediation Conceptual Site Model (CSM) for Phase 4B & 5D										
Sources	Key Contaminants	Receptor	Pathway	Pre-Remediation			Post-Remediation			
				Probability	Consequence	Risk Level	Mitigation	Probability	Consequence	Risk Level
							detailed site investigation and risk assessment.			
		Property: Future on Site Buildings Future on Site Infrastructure	Potential migration and build-up of soil/ water-derived vapours via Made Ground.	Low	Medium	Moderate	Additional post-remedial ground gas/ vapour assessment is required to further assess and zone the Site.	Unlikely	Medium	Low
		Controlled Waters: Secondary B Aquifer Private Drainage System: Ellen Reen	Potential migration of contaminants through shallow groundwater.	Moderate	High	Moderate	Remedial works to remove free product/ grossly contaminated soils and treatment of soils/ dissolved phase will significantly reduce the sources onsite reducing the risk to receptors. Low permeability of Tidal Flat Deposits means a viable pathway for downward migration is unlikely.	Low	Medium	Low to Moderate

5.0 Controlled Waters Detailed Quantitative Risk Assessment

5.1. RLL CWDQRA Summary

In 2019, RLL prepared a Controlled Waters Detailed Quantitative Risk Assessment (CWDQRA) for the wider Glan Llyn development site (**Appendix C**). This assessment incorporated a comprehensive dataset of concentrations of contamination recorded in soils across the development, and included data taken from the 2018 investigations within the Site. Screening analysis of soil, soil leachate, groundwater and surface water data revealed potential moderate to low levels of inorganic and organic contamination present onsite in line with contaminants associated with former steelworks sites. Made Ground comprising clayey sandy gravels with local slag, burnt shale, tarmac, concrete, brick and mudstone was found to be a potential source of contamination. Calculation of representative re-use criteria for a commercial end use was undertaken using a dilution assessment methodology based on the site-wide water balance, incorporating site specific permeability and infiltration parameters. No allowance was made for dilution of discharged waters within Monks' Ditch itself as part of this calculation as, this being the receptor, it is proposed that the water quality in this Controlled Water be maintained (as far as possible) at EQS values.

Comparison of re-use criteria against available soil chemical testing established that the much of the Made Ground was likely to be suitable for re-use onsite, however, localised source materials existed containing higher concentrations of contamination (particularly elevated concentrations of iron, manganese and vanadium), and ammoniacal and cyanide components, may require remediation, or offsite disposal.

Further modelling of these contaminants was undertaken using Remedial Target Methodology (RTM) to assess the potential extent of attenuation of these specific determinands within the ground where these soils may be placed, with the receiving surface waters being assumed to be existing blueways (reens), which were considered as the Compliance Points. The compliance point for the Business Park is at the pumping station and will require an enacted permit for discharge to occur.

Initial modelling was carried out by Atkins (Glan Llyn, Llanwern Controlled Waters Detailed Quantitative Risk Assessment dated February 2017), with this approach being adopted within later revisions of this Report in the Rodgers Leask, Controlled Waters Detailed Quantitative Risk Assessment, Glan Llyn (sitewide) Update (2019), using the Equation presented in the EA Table 5.2 – soil-water partitioning of the EA Remedial Targets Methodology Guidance (2006) where a pore-water concentration (Cp) was determined from soil concentration analyses to derive soil reuse criteria at the site as a whole. Subsequently, and purely to gauge the potential distance that re-engineered Made Ground could be placed from the respective Compliance

Point(s), further modelling was carried out for specific determinands using the EA RT Excel Worksheets, based on maximum and average soils concentrations determined within samples of re-engineered Made Ground and available site derived data.

Further modelling was carried out for specific determinands (including specific PAHs) using the EA Remedial Target Excel Worksheets, based on maximum and average soils concentrations did indicate that there was little attenuation of the initial porewater PAH concentrations on migration within the re-engineered Made Ground toward the nearest re-en Receptors. However, the presence of elevated porewater PAH concentrations were only theoretical and based on calculated values derived using the Equation presented in the EA Table 5.2 – soil-water partitioning of the EA Remedial Targets Methodology Guidance (2006). Actual PAH concentrations determined more recently in groundwater samples recovered (where sufficient groundwater was available for sampling purposes), were generally lower, and potentially significantly lower, than the calculated values which were derived using soils analyses data. Additionally, as previously mentioned, there was little evidence obtained of hydraulically continuous groundwater horizon(s) within the re-engineered Made Ground beneath areas proposed for residential and commercial development. Therefore, there have been no proven PAH (or other contaminant) migration pathways towards the reens.

As the data used within the CWDQRA has utilised ground investigation data taken from within the Site, it is therefore considered that the findings of this assessment are representative of the Site and therefore adoption of the calculated re-use criteria and recommendations presented within the CWQRA are appropriate. To confirm this RLL have prepared an addendum CWDQRA for Phase 4B & 5D, this is presented within **Appendix D**.

5.2. HFCL Glan Llyn: Soils Validation Strategy for Protection of Controlled Waters

Following queries from Natural Resources Wales (NRW), H F Consulting Limited (HFCL) were commissioned by RLL to assist with NRW liaison and reporting pursuant to the discharge of PC28. Following discussion with NRW, RLL and the developer, HFCL prepared a revised methodology for the validation of soils in relation to the protection of controlled waters.

The assessment included distance specific remedial targets that model the attenuation of contaminants in the saturated zone allowing for advection, dispersion, retardation and decay during transport. In addition to the inclusion of distance specific remedial targets, further statistical and spatial analysis was carried out on contaminants of concern.

More detail is provided in the HFCL Glan Llyn: Soils Validation Strategy for the Protection of Controlled Waters (30937 R2) (**Appendix E**).

6.0 Remediation Strategy

6.1. Remediation Approach

Based on the results of the previous ground investigations and CWDQRA, the key driver for the remediation of the Site is considered to be the removal of significant sources of contamination, below ground obstructions and re-engineering of near-surface Made Ground to reduce infiltration for the protection of surface waters and installation of a clean cover system for the protection of human health.

Encountered chemical exceedances of S4ULs Residential with Plant Uptake Criteria are shown on RLL Drawing 18669-RLL-25-XX-DR-O-0754-P01, exceedances of relevant SRVs are shown on RLL Drawing 18669-RLL-25-XX-DR-O-0751-P01, both in **Appendix A**.

The potential risks to controlled waters when a future connection exists have been assessed in an CWDQRA report included as **Appendix F** (18669-RLE-19-XX-RP-O-0006, dated August 2019), the methodology for assessing these risks has been presented in the Hannah Fraser Soils Validation Strategy for Protection of Controlled Waters (**Appendix E**).

Protection of human health will be achieved by breaking the potential pathway with the provision of suitable clean cover or construction of hardstanding. Gas protection may be required.

6.2. Remediation Specification

6.3. Proposed Sequence of Deliverables

The sequence of deliverables listed below is proposed:

- Materials Management Plan to enable the movement and re-use of excavated and stockpiled materials in accordance with the limitations set out in this document.
- Removal of vegetation.
- Excavation and turnover of Made Ground to natural clay and removal of unsuitable material and buried obstructions.
- Treatment or offsite disposal of impacted soils (where required).
- Chemical and geotechnical validation of the placement of material following turnover.
- Post remediation ground gas and vapour assessment.
- Preparation of a Remediation Validation Report.
- Regulator liaison and submission pursuant to the discharge of relevant planning conditions; and
- Onward housebuilder obligations to include.
 - a. Placement and validation of a clean cover system (where required).

- b. Provision and validation of appropriate gas / vapour membranes in buildings (where required).
- c. Designing of appropriate concrete for aggressive ground.
- d. Installation of appropriate chemical resistant water pipes.

6.4. Removal of Obstructions

A Materials Management Plan (MMP) will be prepared to allow the on-site reuse of materials in accordance with the CL:AIRE Definition of Waste, Development Industry Code of Practice.

The recommended approach involves excavation of Made Ground to a depth where the natural underlying Tidal Flat Deposits are exposed. Obstructions, where they are unsuitable for retention, shall be removed leaving only the supporting piles. Supporting piles shall be cropped at the level of the underlying natural geology.

The recyclable materials generated (i.e. concrete removed from floor slabs, foundations and buried structures) are to be moved to a material processing area where they will be screened, crushed and validated for re-use within the onward development, in accordance with the MMP. Appropriate revisions will be made to the approved MMP as required.

Asbestos has previously been encountered as free fibres in the Made Ground. Concrete shall therefore be assessed prior to crushing in order to limit the risk of asbestos contamination of crushed concrete stockpiles and care shall be taken to ensure it is not cross contaminated with Made Ground.

Drawing 18669-RLL-25-XX-DR-O-0752-P01 presented in **Appendix A** shows the location of buried obstruction encountered during the Phase 4B & 5D ground investigations. However, other unencountered buried obstructions may be present across the Site.

6.5. Visual Evidence of Contamination

As part of previous investigations, some visual and olfactory evidence of contamination has been identified (see Section 3.9) within the Site. Additional caution and supervision should be taken when undertaking turnover within these areas. Any gross contamination of soils or groundwater encountered in these areas should either be treated or removed from Site in accordance with procedures outlined in Section 7.0.

Where visual or olfactory evidence of contamination is encountered during the turnover works it will be excavated with a watching brief to chase out and stockpiled separately. Subsequent suitability testing and assessment will be undertaken to determine if the material can be reused.

During remediation, if any material exhibits previously unencountered significant evidence of contamination (i.e. free product or grossly impacted soils) the contractor should inform the Client's Engineer on and propose a method for its treatment that will allow re-use (at the supervising engineers discretion) or, options for off-site disposal.

6.6. Protection of Human Health

The remedial criteria adopted for the clean cover system at the Site are based on S4ULs (suitable for use levels) and C4SLs (category 4 screening levels) for a residential end use with plant uptake.

It is likely that human exposure to contaminants during the operational phase of the development will be restricted to inhalation of dust and dermal contact/ ingestion of contaminants within gardens, public open spaces and soil adhering to home grown produce. Risks to human health may be mitigated through either excavation of the contaminants, provision of clean cover, or construction of hardstanding (or a combination of these); this is intended to prevent exposure to these contaminants and thus break the pollutant linkages.

The overall philosophy for remediation of the Site with regards to protection of human health is therefore severance of linkage pathways, by means of the removal of significant sources of contamination from the sub-surface and installation of a clean cover system or hardstanding in order to provide a safe development platform. This includes a turnover strategy as part of the earthworks. Additional measures, such as the provision of clean cover, soil-gas protection, water pipe protection etc, are then to be provided by the future housebuilder.

6.7. Protection of Controlled Waters

The CWDQRA (**Appendix C**) states that once remediation has been undertaken and the removal of any free product and highly contaminated soils has been completed in accordance with the remedial targets is unlikely to pose a risk to controlled waters.

The ground investigation data has been assessed against the RLL criteria within the Phase 4B 5D controlled waters risk assessment (**Appendix D**), however it is intended that the controlled waters validation will be completed in accordance, and in line with the criteria set out in, the Hannah Fraser Soils Validation Strategy (**Appendix E**).

RLL Drawing 18669-RLL-25-XX-DR-O-0751-P01 (**Appendix A**) shows the locations where exceedances of the HFC reuse screening criteria were recorded during the 2018 trial pitting, the re-use of materials exceeding the specified criteria should be done so in accordance with the Hannah Fraser Soils Validation Strategy (**Appendix E**).

Grids that are lacking trial pitting data were not investigated due to the presence of onsite obstructions, specifically stockpiles. These locations will be subject to further investigation and the findings will be documented in a separate validation report.

The earthworks will be validated in accordance with the Hannah Fraser Soils Validation Strategy (**Appendix E**).

To align with this strategy the works shall comprise the “*excavation of Made Ground materials, removal of materials unsuitable for re-use in the development platform, and re-compaction of suitable Made Ground materials as an engineered fill. A drainage layer, formed as part of the normal construction phase, will then be installed above the engineered fill layer, to reduce infiltration to the Made Ground.*”

Following the earthworks operation Hydraulic conductivity rates will be reduced to 1×10^{-6} m/d or less for the engineered fill. These rates will be validated by taking at least three hydraulic conductivity measurements per phase, with a guide density of one test per 6.25 ha. During the construction phase a drainage layer will be placed comprising appropriate granular material and evidence of its installation layer will be a requirement of the construction phase.

A controlled waters validation report shall be prepared on completion of the earthworks to present the verification information relating to the remediation works undertaken on the Site relating to controlled waters.

6.8. Re-Use of Arisings

Trial pitting has been undertaken across the Site to assess and characterise the Made Ground for suitability for reuse as detailed in Section 3. The results were compared to S4ULs (suitable for use levels) and C4SLs (category 4 screening levels) for a residential end use with plant uptake presented in **Table 1** and **Table 2** included to the rear of this report.

Material present within the Site shall be reused where suitable, in accordance with an approved Materials Management Plan prepared in accordance with the CL:AIRE Definition of Waste, Development Industry Code of Practice.

Where material present within the Site is not considered suitable for retention, it shall be transferred and re-used in the commercial phase of the development, in accordance with an approved Materials Management Plan prepared in accordance with the CL:AIRE Definition of Waste, Development Industry Code of Practice.

Where material is not suitable for either a residential or commercial end use, or during remediation, if any material exhibits previously unencountered significant evidence of contamination (i.e. free product or grossly impacted soils) the contractor should inform the Client's Engineer on and propose a method for its treatment that will allow re-use (at the supervising engineers discretion) or, options for off-site disposal.

The re-use of treated materials will be subject to regulatory approval and an approved Materials Management Plan prepared in accordance with the CL:AIRE Definition of Waste, Development Industry Code of Practice. On-site treatment and processing will be undertaken where possible to reduce contaminant concentrations so the arisings will be either:

- Suitable for shallow residential garden use (part of the clean cover layer);
- Suitable for re-use at depth (e.g. below the clean cover or within POS landscaped areas).

If treatment is required, then testing shall be undertaken at a frequency of 1 sample per 100m³ and compared against the re-use screening criteria for the various potential end-uses detailed in **Table 1** and **Table 2** included to the rear of this report.

6.9. Materials Management Plan

In the interest of sustainability and in order to avoid the unnecessary transport of material from the Site to landfill, it is proposed to re-use the Made Ground and any recycled aggregates generated as part of the works. Re-use of material will be in accordance with the CL:AIRE's Definition of Waste, Development Industry Code of Practice (DoW:CoP). A compliant Materials Management Plan (MMP) will be prepared, or an existing one updated to include the requirements of this strategy.

Material movements shall be tracked by the Contractor on daily or weekly material tracking sheets, to include:

- Survey plans of material sources and destinations.
- Summaries of volumes and composition of materials moved.
- Associated chemical testing to demonstrate suitability.
- Locations and ongoing volumes of temporary stockpiles.

Material movement records shall be maintained by the Contractor on-Site for inclusion in the Validation Report.

6.10. Clean Cover System

To reasonably prevent contact between Site end users and contaminants within the Made Ground, a clean cover system shall be placed in gardens and areas of public open space. Following completion of the remediation works, the Site shall be left 750mm below from Finished Floor Levels (FFL). This is to incorporate drainage arisings (150mm) and facilitate the installation of the clean cover system for residential gardens, which will comprise a minimum of 600mm of suitable material (or 300mm in areas of public open space). Material is considered suitable after being assessed against the criteria detailed in **Table 1** and **Table 2** at the rear of this document. Material proposed for reuse within residential gardens is to be assessed in accordance with **Table 1**. Material to be reused within public open

space near residential areas (i.e. landscaping for an apartment block) is to be assessed in accordance with **Table 2**.

The cover system will comprise suitable subsoil and topsoil and is to be placed by the onward developer. A Validation Report is required for the cover system and this shall be submitted to the regulators to satisfy planning conditions. It is advised that the onward developer also share details of the clean cover system with their chosen housing insurer (NHBC, LABC or equivalent) for approval in accordance with their guidance. The clean cover requirements for areas of public open space are anticipated to be 300mm of suitable material in accordance with **Table 2**.

6.11. Ground Gas Protection Measures

The assessment of ground gas protection measures is to be updated following the remedial works. The classification of the Site will depend on the competency of the upper clay of the Tidal Flat Deposits. A site-specific ground gas assessment is recommended following the earthworks. In accordance with BS8485:2015+A1:2019.

Risks from vapours has not been assessed as part of the 2021 ground investigation and will be assessed as part of the post remediation ground gas and vapour assessment detailed within this Remediation Strategy.

6.12. Risks to Construction Workers

Site workers are advised to follow normal health and safety procedures, including the use of suitable PPE (e.g. gloves and overalls) and following hygiene rules, particularly when handling the Made Ground. Contamination is present within the Made Ground (including asbestos), therefore specific contractor RAMS (with reference to guidelines presented in Control of Asbestos Regulations 2012) may need to be produced to mitigate the risks.

A watching brief should be maintained during excavation works as part of the development to check for the presence of previously unexpected contamination.

6.13. Onward Developer Actions

The following actions are deferred to the onward developer:

- Placement of a clean cover system (600mm), construction materials (including piling mat), soils in residential gardens and areas of public open space as part of the overall development;
- Validation of the thickness and chemical composition of soils placed in gardens (as part of the clean cover system) in accordance with NHBC (or equivalent housing insurer) recommendations;

- Provision of appropriate gas/ vapour membranes in buildings and validation in accordance with BS: 8485:2015+A1:2019 and CIRIA C735, if necessary;
- Designing concrete in accordance with BRE Special Digest 1 will prevent significant risks from concrete degrading if in contact with aggressive ground; and
- Installation of appropriate chemical resistant water pipes (if required).

6.14. Environmental Monitoring

The Construction Environmental Management Plan (Atkins, April 2014) should be read in conjunction with this section for the environmental monitoring requirements.

6.15. Surface Water Monitoring

Phase 4B & 5D is 50m south of Ellen's Reen and bound to the south by Central Lake of the site drainage system, however, no connection between the site private drainage system and Monks Ditch currently exists. Surface water monitoring shall be undertaken from the wider private drainage system and from Monks Ditch at numerous appropriate locations across the site, shown on Drawing 18669-RLL-24-XX-DR-O-0544-P04 (**Appendix A**). Visual monitoring of the surface waters will be undertaken on a daily basis and chemical samples will be taken on a fortnightly basis.

The results of chemical analysis shall be compared against the EQS determinands detailed in **Table 4** at the end of this document.

6.16. Dust and Air Quality

Dust monitoring is required throughout the works as residential and commercial receptors are located near to the Site boundary on all sides. Monitoring locations are detailed in the Construction Environmental Management Plan (CEMP); however the locations shall be reviewed and adapted based on working areas and actual conditions encountered on Site.

6.17. Noise and Vibration

The Contractor will ensure that operations are undertaken in a manner considerate to sensitive receptors, including adjacent residential properties. This includes limiting noise and vibration as far as is reasonably practicable. Details of required monitoring are included in the CEMP.

7.0 Contingency for Unexpected Contaminated Soil

Should the Contractor or Employer's Environmental Engineer identify suspected areas of gross contamination, the suspected contaminated soils shall be excavated and stockpiled separately on polythene sheeting with appropriate bunding and suitably identified.

Contaminated soils shall be defined as soils exhibiting visual evidence of contamination (e.g. soils with hydrocarbon content above the saturation limit) or olfactory indications of contamination (e.g. organic odour indicative of hydrocarbons). Initial vapour screening of the impacted Made Ground/ natural deposits may be undertaken using a photoionization detector (PID), where visual or olfactory evidence of organic contamination is recorded.

Representative samples of affected soils shall be tested for the suspected contaminants of concern. The minimum number of samples will be five i.e. one from each side and one from the base. As a minimum and dependent on contamination type, one sample shall be taken for every 10m along the side per contaminated horizon and one sample per 100m² base area. If the thickness of the contaminated zone is greater than 1.0m, one sample shall be taken per 1.5m of vertical face. Results shall be compared against the criteria detailed in the tables at the rear of this document, which will determine a suitable end-use and the material will be re-used accordingly (in accordance with the MMP). Should samples exceed the criteria, soils will be deemed unsuitable for re-use without liaison with the regulator and further risk assessment and/or treatment. Any material deemed unsuitable following further risk assessment shall require treatment or disposal from the Site.

Should soils require disposal from the Site, the soil's chemical results shall be used to begin the assessment of the material as non-hazardous or hazardous waste. Waste Acceptance Criteria (WAC) testing may be required prior to off-site disposal. Material sent to landfill must be hauled by a registered waste carrier in accordance with the Waste Duty of Care: Code of Practice. The Contractor shall be responsible for keeping all records including waste transfer notes.

Validation testing of the sides and base of the resultant excavation shall be carried out by the appropriate monitoring Engineer, in accordance with Section 9 of this document. The contaminated soils will be deemed to have been successfully removed once the validation samples of the sides and base meet the respective criteria for re-use.

The extent and location of contaminated soils removed shall be surveyed and recorded by the Contractor.

8.0 Re-use of Site Won Material

8.1. Re-use of Site Generated Materials

In the interest of sustainability and in order to avoid the unnecessary transport of material from the Site to landfill, it is proposed to re-use the Made Ground and any recycled aggregates generated as part of the works. Re-use of material will be in accordance with the CL:AIRE Definition of Waste, Development Industry Code of Practice. A compliant Materials Management Plan has previously been prepared for the wider site.

Material movements shall be tracked by the Contractor on daily or weekly material tracking sheets, to include:

- Survey plans of material sources and destinations.
- Summaries of volumes and composition of materials moved.
- Associated chemical testing to demonstrate suitability.
- Locations and ongoing volumes of temporary stockpiles.

Material movement records shall be maintained by the Contractor on Site for inclusion in the Validation Report.

8.2. Soil for Formation of Clean Cover

The placement of clean cover will be the responsibility of the onward developer.

Subsoil and topsoil proposed for formation of capping layers shall be tested prior to import and/ or placement and compared to screening criteria in **Tables 1 and 2** included at the rear of this document. Soils shall be tested at a frequency of one sample per 250m³ and a minimum of three samples per source.

8.3. General Site Fill Beneath Clean Cover

Suitable site won materials and existing validated stockpiled material may be used as general fill below formation level (i.e. below the clean cover), providing they are chemically suitable when compared with the criteria in **Table 3**. Soils that are impacted with free product or grossly contaminated will not be acceptable for re-use without further treatment/ assessment. Screened materials will be tested at a frequency of 1 sample per 500m³ and compared against the screening criteria detailed at the rear of this document.

If asbestos is identified, dependent upon the concentration, it shall be re-used in accordance with the depths detailed in the Institute of Occupational Medicine: Llanwern, Assessment of Asbestos Contamination at Former Llanwern Steelworks Site. The report concludes that a minimum of 600mm of clean soil (the clean cover system) will be placed across the Site. Beneath the clean soils, Made Ground may

be used in residential areas if asbestos contamination is less than 0.02% (200ppm) and used in commercial areas if asbestos contamination is less than 0.03% (300ppm).

Should material be found to contain contaminants above the re-use criteria, then the upper 95th percentile value (US⁹⁵) and upper confidence limit of the mean value may be used to assess the material for suitability for re-use subject to agreement with the Local Authority.

8.4. Offsite Disposal

Material sent to landfill must be hauled by a registered waster carrier in accordance with the Waste Duty of Care: Code of Practice. The Contractor shall be responsible for surveying the source areas of all off site material, recording volumes, relevant compliance and classification testing results and the keeping of records including waste transfer notes, consignment notes and material tracking sheets for inclusion in the Validation Report.

9.0 Validation

9.1. General

The remediation and/ or earthworks activities described in this strategy will be supervised full-time by the suitably qualified Monitoring Engineer. As an addendum to the sitewide remediation strategy, following consultation with Newport City Council and Natural Resources Wales, technical notes have been prepared to capture additional relevant phase specific information as part of the validation exercise. The technical notes prepared as an addendum to the remediation strategy are presented in **Appendix F**. Technical Note 0192, ref. 18669-RLL-22-XX-RP-O-0192 (**Appendix F**) presents additional information relating to the remediation strategy and the setting out the process to collect additional validation information to assess the contamination status of the formation surface. Technical Note 260, ref. 18669-RLL-22-XX-RP-O-0260 (**Appendix F**) presents a validation plan to assess the hydraulic conductivity of the reengineered Made Ground and to assess the sampled perched water samples against the pore water concentrations assumed within the CWDQRA.

Remediation shall be confirmed using the methodology presented in the Validation of Remediation of Land Contamination - Science Report SC030114/R1 (Environment Agency, 2010).

A Validation Report shall be prepared on completion of the works. The Validation Report will be submitted to the Local Planning Authority pursuant to the discharge of relevant planning conditions.

Post-remediation ground gas/ vapour monitoring will be required to further zone the Site with regard to the required gas/ vapour protection measures.

9.2. Validation of Turnover

Turnover works will be undertaken under a full-time watching brief by the Monitoring Engineer. Material exhibiting visual or olfactory evidence of contamination will be segregated and further assessed. Records of wider material movements will also be kept and detailed within the MMP.

Non-targeted grid validation sampling shall be undertaken at a frequency of 1 sample per 500m³ of placed material. Formation level is to be left up to 600mm below final floor level (FFL) to account for the placement of clean cover (300mm in areas of POS). Soil samples shall be compared to the following criteria.

- Made Ground used within residential gardens as part of the clean cover system (i.e. above formation level) shall be compared with the criteria detailed in **Table 1**;

- Made Ground used within public open space as part of the clean cover system (i.e. above formation level) within or near a residential area shall be compared with the criteria detailed in **Table 2**;
- Made Ground used underlying residential areas at depth (i.e. below formation level) shall be compared with the criteria detailed in **Table 3**; and
- A 600mm clean cover system will be placed across the Site. Beneath the clean soils, Made Ground may be used in residential areas if asbestos contamination is less than 0.02% (200ppm).

Validation will generally comprise the following procedure:

I. Delineation of Unexpected Contamination (if encountered)

Material exhibiting evidence of visual or olfactory gross contamination will be removed. A photo ionization detector (PID) should be used on-site to determine the extent of the contamination. Soil sampling and testing shall be undertaken until the results meet the respective re-use criteria detailed in **Table 1** and **Table 2** and the material is not grossly impacted, at which point the extent of the potential hot spot will be regarded as having been delineated.

II. Excavation of Contaminated Material

Material which does not meet the re-use criteria detailed in the tables at the rear of this document or is visually impacted with free product/ grossly impacted will be removed by the Contractor and stockpiled on-site for further assessment/treatment; if necessary the material will be removed from Site. The extent of the excavation may be increased should it be deemed necessary, for example, if further visual or olfactory evidence of significant contamination is present.

III. Hot-Spot Validation Sampling (if required)

Soil samples will be obtained for validation testing on the sides and base of the hot-spot excavation following soil removal. Samples will be tested for the contaminants that did not meet the respective criteria at that particular hot-spot location.

The minimum number of samples will be five i.e. one from each side and one from the base. As a minimum, and dependent on contamination type, one sample shall be taken for every 10m along the side per contaminated horizon and one sample per 100m² base area. If the thickness of the contaminated zone is greater than 1m, one sample shall be taken per 1.5m of vertical face.

If validation samples do not meet the criteria, further soil will be excavated horizontally and vertically and additional validation samples taken. The procedure will be repeated until samples meet the remedial targets. Any deviation from the above methods will require liaison and approval from the regulator.

IV. Survey

The extent of the excavation will be surveyed to Ordnance Datum (coordinates and levels) and a plan produced showing the location of relevant samples taken. Obstructions left in-situ will also be recorded on the survey.

An as dug survey will also be completed for the whole area of the earthworks across the Site showing depth of excavation / turnover per 5m grid and increased survey points array for any deeper excavations.

V. Sampling, Sample Transfer and Analytical Laboratories

Soils for chemical testing shall be sampled in accordance with the following British and Eurocode Standards, BS 10175:2011+A2 2017 – ‘Investigation of potentially contaminated Sites – Code of practice’, Eurocode 7, and the BS 5930:2015 – ‘Code of Practice for Site investigations – Incorporating Amendment No.2’ for contamination testing and for geotechnical testing.

Sample containers required for soils shall include vials for volatile organic compound (VOC) testing, amber jars for hydrocarbon testing and a 1kg sized plastic containers for testing of metals and asbestos screening.

Soil, groundwater and surface water samples are to be stored in a cool box, maintained at a temperature between 2°C and 4°C in darkness and shall be transported under these conditions to the accredited laboratory.

Internal and external laboratories shall be UKAS/MCERTS (or equivalent) accredited or it shall be demonstrated that appropriate quality systems have been implemented in lieu of accreditation for non-accredited tests.

9.3. Validation of Clean Cover

It is proposed that clean cover in residential areas shall be placed as part of the construction of each plot. The clean cover shall be 600mm thick and comprise suitable construction materials, subsoil and topsoil. Clean cover will also be required in areas of public open space within the residential and commercial development of 600mm thickness.

Placement and validation of the clean cover layer, either construction materials or soils in residential gardens, shall be undertaken by the housebuilder in accordance with requirements of the regulators and NHBC.

9.4. Geotechnical Validation

Excavated material will be placed, compacted and tested for compliance with a phase specific Earthworks Specifications. Areas of deeper Made Ground, fill and remnant structures will be surveyed and recorded on a drawing.

10.0 Supervision and Reporting

The post-demolition and remediation works described in this report shall be supervised by the suitably qualified Monitoring Engineer.

Survey plans and test results shall be presented within the Validation Report.

The Contractor shall be responsible for obtaining the necessary licences, permits and consents for the works (correspondence shall be forwarded to the Employer's Environmental Engineer) with the exception of the Materials Management Plan and associated Declaration to CL:AIRE, which shall be updated by the Employer's Environmental Engineer upon regulatory approval of this Remediation Strategy.

The Contractor shall maintain records of:

- Survey plans and material tracking of the movements of material from source to final destination.
- Base of excavation and obstruction survey.
- Type and volumes of any materials removed from the Site for disposal, together with the Duty of Care documentation / waste transfer notes.
- Geochemical and geotechnical sampling locations,
- Records of the works including Daily Records Sheets.
- Health and Safety documentation.
- Noise and dust monitoring carried out.
- Records of the complaints received regarding noise and dust.

The Contractor's Environmental Engineer will prepare a Validation Report for the remedial works undertaken under their supervision. The Validation Report shall be compliant with the Environment Agency's Land Contamination Risk Management (LCRM) guidance and 'Verification of remediation of land contamination (SC030114/R1)', providing the following:

- Details of the earthworks and material movements completed.
- Details of hot-spots/ contaminated material removal (if required),
- Details of the validation and verification analytical testing.

The Validation Report shall be submitted to the regulatory authorities to satisfy the requirements of the planning permission with respect to contamination issues. The report will also contain all earthworks testing data, proof of compliance with the targets and all survey data.

Tables

Table 1: Assessment Criteria for Clean Cover in Residential Gardens (600mm): Residential End Use with Homegrown Produce

Category	Determinand	Criteria mg/kg			Source
	Arsenic	37			a
	Boron	290			b
	Cadmium	26			a
	Chromium VI	6			b
	Chromium III	910			b
	Lead	200			a
	Elemental Mercury	1.2			b
	Inorganic Mercury	40			b
	Methyl Mercury	11			b
	Nickel	130			b
	Selenium	250			b
	Beryllium	1.7			b
	Copper	2400			b
	Vanadium	410			b
	Zinc	3700			b
Soil Organic Matter Content (SOM) dependent		SOM 1%	SOM 2.5%	SOM 6%	
Phenols	Phenol	120	200	380	b
Petroleum Hydrocarbons	Aliphatic EC 5-6	42	78	160	b
	Aliphatic EC>6-8	100	230	530	b
	Aliphatic EC>8-10	27	65	150	b
	Aliphatic EC>10-12	130 (48) ^{vap}	330 (118) ^{vap}	760 (283) ^{vap}	b
	Aliphatic EC>12-16	1100 (24) ^{sol}	2400 (59) ^{sol}	4300 (142) ^{sol}	b
	Aliphatic EC>16-35	65000 (8.48) ^{sol}	92000 (21) ^{sol}	110000	b
	Aliphatic EC>35-44	65000 (8.48) ^{sol}	92000 (21) ^{sol}	110000	b
	Aromatic EC 5-7 (Benzene)	70	140	300	b
	Aromatic EC>7-8 (Toluene)	130	290	660	b
	Aromatic EC>8-10	34	83	190	b
	Aromatic EC>10-12	74	180	380	b
	Aromatic EC>12-16	140	330	660	b
	Aromatic EC>16-21	260	540	930	b
	Aromatic EC>21-35	1100	1500	1700	b
	Aromatic EC>35-44	1100	1500	1700	b
	Aliphatic + Aromatic EC>44-70	1600	1800	1900	b
Polycyclic Aromatic Hydrocarbons	Acenaphthene	210	510	1100	b
	Acenaphthylene	170	420	920	b
	Anthracene	2400	5400	11000	b
	Benz(a)anthracene	7.2	11	13	b
	Benzo(a)pyrene	2.2	2.7	3.0	b
	Benzo(b)fluoranthene	2.6	3.3	3.7	b
	Benzo(ghi)perylene	320	340	350	b
	Benzo(k)fluoranthene	77	93	100	b
	Chrysene	15	22	27	b