GroundSolve Ltd
Consulting Geotechnical Engineers

REMEDIATION STRATEGY FOR BRYMBO HERITAGE CENTRE – NEW DEVELOPMENT AT THE MACHINE SHOP

GSL3156R01

VERSION 1

27 AUGUST 2024

FINAL

Prepared for:

Cadarn Consulting Engineers

Prepared by E Rowland

GroundSolve Ltd

DOCUMENT CONTROL

Report No. :	GSL3156R01
Report Status:	FINAL
Version No.:	1
Project Engineer:	J Thorburn
Date of Issue:	27/08/2024

This report has been prepared by GroundSolve Ltd with all reasonable care and diligence, within the best practice and guidance current at the time of issue within the proposed redline boundary and proposed Site end use as presented by the Client.

This report is confidential to the Client and GroundSolve Ltd accepts no responsibility whatsoever to third parties to whom this report is presented.

Version No.	Description of Issue / Revision	Date of Issue	Author	Reviewed & Approved By
1	FINAL	27/02/2024	Eve Rowland MESci FGS	J Thorburn BSc FGS

CONTENTS

1 INTRODUCTION 4
1.1 Proposed Development 4
1.2 Objectives 6
1.3 Previous Investigations 7
1.4 Limitations 7
2 SITE DETAILS AND DESCRIPTION 8
3 PREVIOUS INVESTIGATIONS 9
4 REMEDIATION STRATEGY 12
4.1 Enabling Works 12
4.2 Summary of Risk Assessments within development area 12
4.3 General Observations and Requirements 13
4.4 Unexpected Contamination 14
4.5 Clean Cover System 15
4.6 Re-Use of Soils 16
4.7 Waste Characterisation and Classification 17
4.8 Gas Risk Assessment 18
5 VERIFICATION PLAN 19
5.1 General 19
5.2 Verification of Earthworks/Remediation 19
5.3 Imported Subsoil and Topsoil 20
5.4 Gas General Verification 21
6 REGULATORY REQUIREMENTS 23
6.1 Remediation 23
6.2 Health and Safety 23
7 REFERENCES 24
8 DEFINITIONS 25

APPENDICES

Appendix A - Drawings
Appendix B - Unforeseen Ground Contamination
Appendix C - Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

1 INTRODUCTION

GroundSolve Ltd was commissioned by Cadarn Consulting Engineers to undertake a Remediation Strategy and Verification Plan for the proposed development at of a new toilet block, kitchen and tour entrance at the existing machine shop at Brymbo Heritage Centre, located at The Old Works, off Gwalia Road, Brymbo, Wrexham, LL11 5AX (the "Site").

This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Welsh Local Government Assoc- Development of Land Affected By Contamination Guide for Developers 2017
- Welsh Land Contamination Working Group (WLGA) - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems
- Part IIA of the Environment Protection Act, 1990
- BS5930:2015+A1:2020: "Code of practice for site investigations"
- BS10175: 2011 +A2:2017 "Investigation of Potentially Contaminated Sites - Code of Practice"
- The Building Regulations 2010. Part C (HM Government 2013)

1.1 Proposed Development

The proposed development comprises the of new developments of a toilet block, kitchen and tour entrance for the Brymbo Heritage Centre with associated car parking, access road, hard and soft landscaping.

Planning Application number P/2024/0325.



Figure 1: Extract of Development Plan BMS-TACP-S-XX-DR-A707 (TACP Architects Ltd).

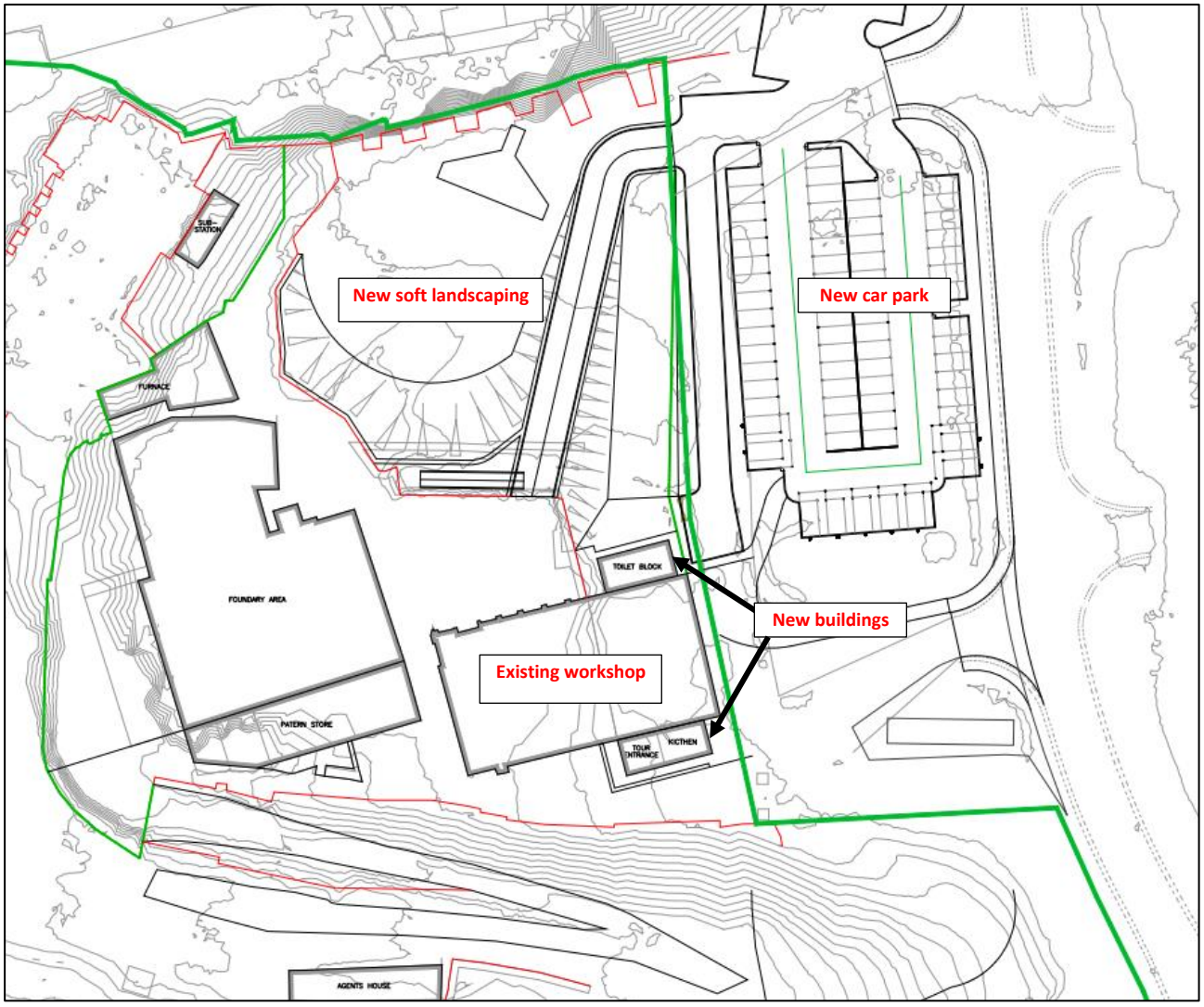


Figure 2: Extract of Development Plan 4866?0002 P01 C01 (Bingham Rawlings Partnership Ltd).

1.2 Objectives

The objective of this document is to present details of the remedial measures required based on the findings of ground investigations and third-party investigations. This report presents how the remediation of the site will be undertaken and sets out how the works will be validated. In addition, this document explains how the works will be permitted under current regulatory regimes. The remediation will ensure that upon completion of the proposed development, the ground and conditions at the site can be shown to be appropriate for its intended use, and that it will not pose unacceptable contamination risks to identified receptors.

The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed end use.

This report provides a Remediation Strategy and Verification Plan in relation to the identified contaminant sources, together with further details of how the developer will deal with encountering unexpected contamination, should this occur.

This document is a working document and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on the conditions encountered. This version of this document is to be issued to regulators for approval (i.e., Wrexham County Borough Council).

1.3 Previous Investigations

The following reports have already been undertaken and will be summarised in Section 3:

- Factual Ground Investigation Report for Brymbo Heritage Centre produced by GroundSolve Ltd (reference: GSL2987R01, dated April 2024).
- Brymbo Steelworks Heritage Area: Land Contamination Review produced by Smith Grant LLP (reference: R2762-R01-v2-Final, dated November 2019).

1.4 Limitations

This report has been prepared for the sole use of Cadarn Consulting Engineers. No other third party may rely upon or reproduce the contents of this report without the written approval of GroundSolve Ltd. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk.

2 SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview.

Site name	Brymbo Heritage Centre.
Site address	The Old Works, Off Gwalia Road, Brymbo, Wrexham, LL11 5AX.
National Grid Reference (NGR)	329490 353578.
Approximate Site area	The area of site is approx. 258ha.
Site shape	The site is irregular in shape, approx. 650m east to west.
Current land use on the Site	The site is currently in use as the Heritage Centre.
Surrounding land uses	Surrounding land uses comprise an enterprise business part to the north. The east, south and west of site comprise residential developments and open land.
General topography and ground levels	No topographical plans have been made available to GroundSolve however it is understood that general site levels slope upwards towards the west.

3 PREVIOUS INVESTIGATIONS

Factual Ground Investigation by GroundSolve Ltd (Reference GSL2987R01, dated April 2024).

The ground investigation works carried out by GroundSolve in April 2024 covered the site subject area of this report as part the Wider Brymbo Heritage Centre redevelopment.



Figure 3: Extract of Exploratory Hole Location Plan .

The phase 2 investigation included 5 No. machine excavated trial pits, in order to gain information on the existing structures and foundations located on site. It was recommended by GSL that a 20-tonne excavator should be used, however the client provided an excavator already on site (1.5 tonne micro excavator). The smaller size of the excavator, along with ongoing archaeological assessment works in the area meant works were restricted.

Made Ground was encountered in all trial pits to the base of excavation, with the exception of TP4 which encountered potentially reworked clay from 0.60m to 0.95m bgl. The trial pits were advanced to maximum depths between 0.50m to 1.20m bgl.

Relict concrete slabs were encountered in TP1. TP1-B to TP4 were unable to be advanced any deeper due to encountering hard/dense material and/or excavator limitations.

In total, 1 No. sample was submitted for heavy metals, PAH and TPH testing. Measured concentrations of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Chrysene and Dibenzo(ah)anthracene have all been recorded exceeding the generic assessment criteria protective of human health for a residential public open space) land use.

Brymbo Steelworks Heritage Area: Land Contamination Review produced by Smith Grant LLP (reference: R2762-R01-v2-Final, dated November 2019).

The Land Contamination Review produced by Smith Grant LLP reviewed the site history, current site conditions and previous ground investigation results.

- Historical mapping shows the site has been subject to significant industrial land use:
    - An ironworks was present on site along with coal mining shafts from 1873 to 1879.
    - As of 1899 the site was renamed to the Brymbo Steel and Iron Works. Variation in buildings on site, with new ones appearing and older structures being demolished occurred over time.
    - As of satellite mapping in 2006, most buildings have been demolished and a significant area of site is overgrown with vegetation.
- Thresholds for human health protection commercial and Public Open Space (POS Parks) uses are exceeded for heavy metals in a minority of the sample population available for review, however these are derived using much higher exposure frequencies and durations than would be anticipated under the planned land uses.
- During excavations and development of new structures there is a small possibility that uncharacterised wastes (inc. hazardous substances) may be exposed. If this changes exposure pathways, then further assessment of risk, limited investigations and supplementary risk assessments can be carried out.
- Pollution risks appear to be limited in regard to surface and groundwater.
- A watching brief during excavations for the presence of ACMs and other suspicious materials that could pose a risk should be conducted.
- New utility trenches should be backfilled with clean materials, and potentially a water supply risk assessment may be required to determine the necessity for chemical resistant pipe materials.
- For new concrete structures, further pH and sulphate, sulphide and total sulphur testing should be conducted.
- Radon and hazardous gas risk assessment should be conducted for new buildings.
- New paths, tracks, roads etc. should be appropriately surfaced in order prevent erosion and improvement to the site drainage should be conducted to ensure no risk to surface water from contamination.
- A basic clean cover system should be installed on site in areas of soft landscaping.

4 REMEDIATION STRATEGY

4.1 Enabling Works

The review of the previous investigations has shown that during the enabling works, if additional contamination is identified then further assessment will be required in order to determine the risk. The results of the chemical testing will be assessed for suitability for residential public open space land use.

4.2 Summary of Risk Assessments within development area

The review of the previous investigations has shown that the site has recorded elevated concentrations heavy metals (nickel and lead) across the site.

Although no ground gas monitoring has been conducted recently in the previous investigations reviewed, based on the site's history for mining and industrial uses, it is recommended that the 2 No. new structures to be developed have Characteristic Situation 2 – Low Risk Scenario protection measures implemented during their construction

The contamination at the site was assessed using the contaminant-pathway-receptor linkage approach. Following the site investigation, the plausible contaminant sources identified were updated and are detailed in **Table 4.1** below.

Table **4.1** – Summary of Contaminant Linkages

Receptor Group	Pollution Source	
	Hotspots	Pervasive
Human Health	The presence of Lead/Nickel	None
Plant Life	No unacceptable contamination.	None
Controlled Waters	No unacceptable contamination.	
Water Supply Pipe Material Assessment	Liaison with water supply company to determine the necessity for chemical resistant pipe materials.	
Human health / property (from ground gases)	The development areas of the site are situated within an area where between 3% and 5% of the properties are above the Radon Action Level and therefore basic Radon Protection Measures are required Based on the site's history, Characteristic Situation 2 (CS2) and radon protection measures are required for this site.	

4.3 General Observations and Requirements

The risk assessments have concluded that remediation measures are required to address risks to human health only, resulting from contamination in the existing shallow Made Ground.

The remedial actions required for the soft landscaped areas are:

- Made Ground can be left in-situ below new building floor slabs and future permanent hard standing (e.g., parking areas, roads, footpaths), excluding service runs and areas where future excavation might be anticipated (assuming all geotechnical requirements are met).
- Remediation is only required for below areas of soft landscaping where Made Ground is present to enable provision of uncontaminated cover soils in areas of soft landscaping (minimum of 300 mm);
- Provision of a clean cover system in soft landscaping. A 300 mm thick cover of 'clean and inert' capping is proposed (comprising 150 mm subsoil and 150 mm topsoil) underlain by a geotextile membrane.

Dust

During the construction works there will be a low risk from dust to on site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Method statement for site activities including control of dust generation;
- having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- only permitting smoking or eating on site in appropriate pre-designated areas.
- the method statement shall have a contingency plan which should be implemented if the presence of asbestos is suspected in groundworks; and

Given the low level heavy metals (principally lead and nickel) and PAHs together with the proximity of residential receptors in the environs of the site and construction workers, control of fugitive dust will be required. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance and that the following measures will be introduced to assist with control of dust generation during the groundworks phase of the works:

- access roads and any stockpiles created during groundworks should be regularly damped down with water;
- vehicles used to transport materials/wastes and aggregates should be enclosed or tarpaulined;
- vehicle movements and speed should be kept to a minimum within the site ;
- dust generating equipment should be located to minimise potential nuisance impacts to receptors as far as practicable; and

- minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.

Main Earthworks

The proposed redevelopment will result in the provision of buildings, hardstanding (including roadways and pavements) and landscaped areas. Areas of buildings and hardstanding will be sufficient to break potential pollutant linkages relating to human health from the limited areas of Made Ground encountered on the site.

Made Ground is currently present within all proposed soft landscaped areas; therefore the following procedures should be applied:

- Removal of Made Ground **as required** to accommodate 300mm thick, clean cover system ;
- Stockpiling of made ground, separately from all other materials, prior to appropriate disposal or reuse at depth;
- Placement of clean cover system, comprising min. 150mm topsoil and 450mm subsoil within any areas of Made Ground

Imported topsoil and subsoil will be required to be analysed for a suitable suite of contaminants in relation to human health (in addition to topsoil being compliant with BS3882:2015). Further details regarding sampling frequency and analysis are presented in Section 4.4.

The proposed development may be carried out in phases; therefore verification of the soft landscaped areas may be required to be carried out in phases.

4.4 Unexpected Contamination

There is the potential that redevelopment works could encounter previously unrecorded hotspots of contaminants. These will be assessed and mitigated in accordance with current good practice.

A ‘watching brief’ is to be maintained by the Principal Contractor during all earthworks at the site. This will enable any previously unidentified contamination on the site to be dealt with in an appropriate manner. Should any unusual ground conditions, visual or olfactory evidence of contamination (including asbestos containing material) be encountered at the site, GSL and the Local Authority should be informed, and further assessment may be required.

If unexpected contamination is encountered, then the procedures set out in **Appendix B** should be implemented.

4.5 Clean Cover System

A clean cover system, 300mm in thickness, shall be installed in all soft-landscaped areas, typically 150mm subsoil and 150mm topsoil underlain by a geotextile membrane.

The council will require that all imported clean cover soils are suitable, and that there is appropriate sampling and testing of this soil, and a verification report is produced. Reference should be made to the Welsh Land Contamination Working Group (WLGA) document - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems'.

For the soft landscaped areas overlying Made Ground:

- Cover systems, 300mm in thickness, are to extend across the whole soft area, regardless of the proposed surface cover.
- Clean cover in garden and soft landscaping area to comprise a minimum thickness of 150mm of topsoil over a 150mm thick subsoil underlain by a geotextile membrane.
- Should extensions be proposed to buildings which are known to have cover systems, it is essential that the cover system is maintained, and soils at depth are not moved to the surface, compromising the cover system.
- No soils are to be imported to site until information on their source, the results of any soil analysis, and an assessment of their suitability for use. This is to ensure that soils used as part of the proposed development are suitable for use, and contaminated soil is not brought on and used within developments.

The Welsh Land Contamination Working Group (WLGA) document *Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems* suggests the minimum frequency for developments of parks/play areas or Public Open Spaces should be 4 sample (separate topsoil and subsoil) for every 250m^3 of imported materials in line with the requirements of Table 4.2.

The proposed testing suite for verification testing of the topsoil and subsoil will include the following:

Table **4.2** – Acceptance Criteria for imported material (Topsoil and Subsoil)

Analyte	Soil Re-Use and Importation Criteria		Analyte	Soil Re-Use and Importation Criteria	
	mg/kg	Reference		mg/kg	Reference
Metals			**BTEX**		
Arsenic (total)	37	S4UL	Benzene	0.087	S4UL
Cadmium (total)	11	S4UL	Toluene	130	S4UL
Chromium (total)	520	HWT	Ethyl Benzene	47	S4UL
Chromium (hexavalent)	6	S4UL	Xylene – 0	60	S4UL
Copper (total)	200	BS3882	Xylene – M or P	56	S4UL
Lead (total)	200	C4SL			
Mercury (total inorganic)	40	S4UL	**Petroleum Hydrocarbons$^{\$}$**		
Nickel (total)	130	S4UL	Aliphatic > EC5 - EC6	42	S4UL
Selenium	250	S4UL	Aliphatic >EC6 - EC8	100	S4UL

Analyte	Soil Re-Use and Importation Criteria		Analyte	Soil Re-Use and Importation Criteria	
	mg/kg	Reference		mg/kg	Reference
Vanadium	410	S4UL	Aliphatic >EC8 - EC10	27	S4UL
Zinc (total)	2,009**	HWT	Aliphatic >EC10 - EC12	130	S4UL
			Aliphatic >EC12 - EC16	1000**	HWT
Inorganic			Aliphatic >EC16 - EC21	1000**	HWT
Sulphate	2400***	-	Aliphatic >EC21 - EC35	1000**	HWT
Phenol	120	S4UL			
			Aromatic >EC5 - EC7	70	S4UL
PAH[&]			Aromatic >EC7 - EC8	130	S4UL
Naphthalene	2.3	S4UL	Aromatic >EC8 - EC10	34	S4UL
Acenaphthylene	170	S4UL	Aromatic >EC10 - EC12	74	S4UL
Acenaphthene	210	S4UL	Aromatic >EC12 - EC16	140	S4UL
Fluorene	170	S4UL	Aromatic >EC16 - EC21	260	S4UL
Phenanthrene	95	S4UL	Aromatic >EC21 - EC35	1000**	HWT
Anthracene	2400	S4UL	Aromatic>EC35-44	1000**	HWT
Fluoranthene	280	S4UL	Aromatic>EC44-EC77	1000**	HWT
Pyrene	620	S4UL	Asbestos	Not detected (<0.001%) for topsoil and subsoil	Lab LoD
Benz(a)anthracene	7.2	S4UL			
Chrysene	15	S4UL			
Benzo(b)fluoranthene	2.6	S4UL			
Benzo(k)fluoranthene	77	S4UL			
Benzo(a)pyrene	2.2	S4UL			
Indeno(123cd)pyrene	27	S4UL			
Benzo(ghi)perylene	320	S4UL			
Dibenzo(ah)anthracene	0.24	S4UL			

4.6 Re-Use of Soils

It is proposed that any existing made ground onsite will not be reused unless placed at a minimum of 300mm below surface level within soft landscaped areas. The location of any Made Ground will be recorded and the thickness of cover system above will be validated within the verification report. The Made Ground will be stockpiled prior to any reuse or until removal off site to appropriate landfill.

4.7 Waste Characterisation and Classification

Excess soil will be sent to a suitable landfill site. A summary of current relatively complex guidance on categorising waste from earthworks is presented in **Appendix C**. A two-phase approach is required comprising comprises:

- Waste Characterisation; and,
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that none of the materials encountered during the investigation can be classified as hazardous.

Waste Classification

In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. No WAC testing was carried out as part of the previous investigations. While WAC testing is not required for non-hazardous waste unless it is to be deposited in an inert landfill, it may be requested by the landfill operator. WAC testing can be carried out to confirm the landfill waste classification and if any pre-treatment is required.

Note that the above assessment should only be seen as an initial guide. Defining the class of waste is carried out on the actual waste being disposed of and the destination landfill site will have the final decision on acceptability of the waste. Therefore, it is recommended that if soils are to be removed from the site, the appointed contractor should approach a landfill site with the available chemical data and seek a formal waste characterisation.

4.8 Gas Risk Assessment

Based on the site's mining and industrial history, the site should be classified as Characteristic Situation 2 (CS2) – Low Risk Scenario for which ground gas protection measures are required for all buildings with enclosed spaces for the development in line with BS8485:2015+A1:2019.

Full Radon protection is also required for the proposed new developments.

The existing Machine Shop will need to be retrofitted in order to install Full Radon Protection measures and CS2 hazardous ground gas protection measures.

From BS8485:2015 + A1:2019, Table 3, the new developments can be classed as a Building Type C (commercial/public) and from Table 4 of this standard, a Score of 2.5 points of protection will be required for Characteristic Situation 2 ground gas conditions.

The standard does not provide set requirements, but it provides a menu of different options which in combination can be used to provide an appropriate Score as set out in Table 4 of this standard.

It is recommended that the proposed protection measures include the following:

- Passive sub floor dispersal layer
  - Good performance– Score 1.5;
- Media used to provide the dispersal layer are:
  - No-fines gravel layer
- Gas resistant membrane – Score 2.0:
  - Visqueen Gas Barrier – suitable for Co2 and Radon protection
  - verified in accordance with CIRIA C735.

The Principal Contractor must ensure that the gas membrane is suitably protected from damage by follow on trades.

5 VERIFICATION PLAN

5.1 General

All stages of the remediation works should be verified independently by suitably qualified and experienced personnel. Verification reports should be prepared for each stage. Verification will be required in two stages:

- Initial earthworks/remediation
- Any of Made Ground material will be stockpiled separately prior to removal to landfill or reuse on site
- Verification of imported subsoil and topsoil within soft landscaped areas overlying Made Ground,

On completion a copy of the Verification Reports should be sent to the Local Authority Environmental Health Officer for their approval so that planning conditions can be discharged. A copy of the report should be sent to the NHBC, local authority building control officer or other similar authority for their approval. Where such organisations are involved in the development process, it is advised that approval be sought to any remediation works from these organisations prior to the commencement of development.

It is important that the information provided to show that remediation was carried out is provided for each area where remediation was required. Where remediation was required at individual areas of a development then it is particularly important to make sure that information is provided for each of those individual areas. It is not sufficient to provide information that simply provides general information about the remediation work that was carried out.

5.2 Verification of Earthworks/Remediation

The verification works/ report should include:

- A description of the works, sample location plan, test results, photographs, interpretation;
- Contractor's documentation (e.g., method statements, plant data sheets etc.);
- Manufacturer's/ supplier's product documentation (e.g., compliance certificates & delivery notes;
- Records of all imported / onsite topsoil, subsoil and soil conditioning material for the site complete with laboratory test certificates demonstrating that the material is suitable for use (if appropriate);
- Verification Engineer's daily logs;
- Photographic Records;
- As-built Drawings;
- Description of how the use of materials links with the Remediation Strategy;
- Reference to site investigation data and risk assessments;

- Record of quantity of materials used;
- Details of any unexpected contamination encountered and how it was dealt with;
- In order that regulatory compliance can be confirmed, a copy of all site licences, consents, Waste Transfer Notes and imported material consignment notes shall be included.

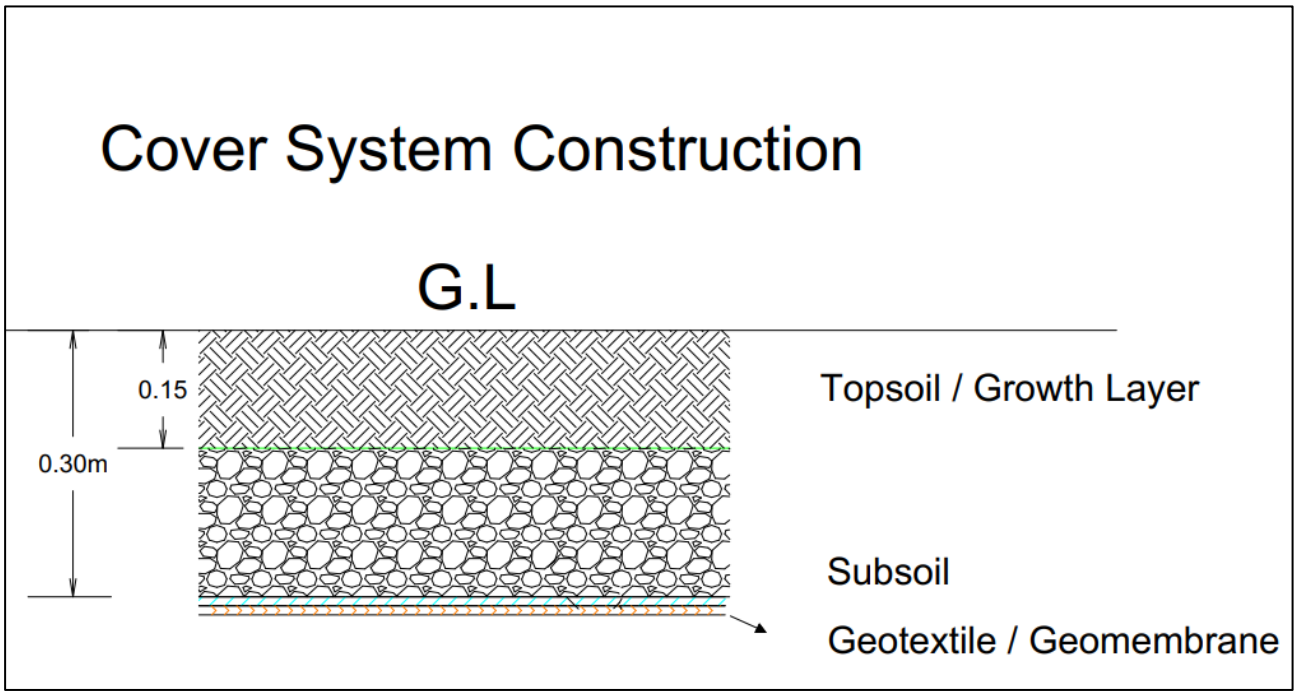


Figure 4: Schematic drawing showing typical cover system construction within soft landscaped areas

5.3 Imported Subsoil and Topsoil

Imported soils will be tested to ensure suitability, GroundSolve propose the following soil validation strategy:

Pre-Placement of Soils

- Imported material (for both sub-soil and topsoil), as detailed above, and compared to appropriate assessment criteria (**Table 4.2**).
- Verification photographs from the proposed garden and soft landscaped areas before the placement of the cover system

Post Placement of Soils

- Place sub-soil and topsoil to a minimum thickness of 300 mm in soft landscaped areas, which includes a suitable thickness of topsoil as a growing medium.
- Method of Validating Capping Thickness:

1. Engineer to verify thickness of capping layer via hand dug exploratory holes from 1 in every 3 plots, plus the soft landscaped area from both topsoil and subsoil.

2. Engineer to digitally photograph every residential garden area and soft landscaped area post capping.

3. All data to form part of a Validation Report which must include prints of all digital photographs titled with plot number, front or rear garden, or location of soft landscaped area.

- Submit a validation report confirming the works have been undertaken in accordance with this agreed strategy.

5.4 Gas General Verification

Verification is required in accordance with CIRIA C735. Verification is defined within CIRIA C735 as:

> *The process of demonstrating that risk has been reduced to meet remediation criteria and objectives based on a quantitative assessment of remediation performance.*

Following the installation of each component that contributes to the gas protection score, verification is required, in accordance with BS8485 and CIRIA document C735 'Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases' (2014).

BS8485 states that "The installation and verification report should present an accurate description of the measures actually applied and present the evidence gathered to confirm that installed measures are suitable for purpose.

The risk-based approach identified within CIRIA C735 guides the verification plan to consider the following:

- Site specific gas regime
- No. of plots
- Complexity of the design and installation
- Qualifications and experience of the workforce (Construction Skills level 2 NVQ diploma)

The site is considered as the following:

- Well characterised as CS2 - Green
- Proposed commercial/public development is small/medium - orange
- The foundations and gas protections measures are relatively simple - green
- Gas protection measures will be installed by combination of general builders with the membrane installed by a specialist contractor, which have extensive experience at installing gas protection systems - orange

All aspects of the ground gas mitigation measures will be checked and validated. No membrane will be validated and signed off by independent verifier until a minimum acceptable standard has been achieved, whereby ensuring the membrane installation is suitably managed to achieve maximum confidence to the suitability of the installed materials.

Verification/validation of gas membrane installation should confirm:

- Inspection of the products being used (membrane, tape, propriety top hats etc.) To ensure they are as specified
- Laps are sufficient in length with edges, seams, service penetrations all sealed.
- The membrane spans across the cavity wall.
- Installation of appropriate Radon protection measures

Any defects identified in any of the points above will be recorded on the verification pro-forma with photographic records, together with corrective actions and subsequent verification checks.

The visit details will be presented in a verification report including photographic evidence for submission to the Planning Authority to complete the discharge of relative planning conditions.

6 REGULATORY REQUIREMENTS

6.1 Remediation

Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g., local authority environmental health officer) to obtain Planning Permission prior to commencement of the works and should be agreed with the NHBC, or similar, or with the local authority building control officer prior to commencement of the works.

6.2 Health and Safety

The works should be undertaken in compliance with all relevant regulations, guidance and legislation. As outlined within the HSE publication "Successful Health and Safety Management – HSG65" this report should inform your development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.

In accordance with the Construction Design and Management (CDM) Regulations 2015, GroundSolve has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report, GroundSolve has discharged and completed all contractual and legal requirements for these positions, and we have no further involvement with the project. The Principal Contractor is responsible for obtaining any necessary approvals from regulatory bodies and third parties to fully implement the works.

7 REFERENCES

BRE SD1 (2005). Concrete in Aggressive Ground. Special Digest 1 (revised edition). IHS BRE Press, Bracknell.

BRE 414 (2001) Protective measures for housing on gas-contaminated land. BRE.

BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites - Code of Practice. British Standards Institution, London.

BS5930:2015+A12020 Code of practice for ground investigations BSI

BS8485 2015 Code of Practice for the design of protective measures for methane and carbon dioxide ground gases in new buildings. British Standards

BS8576-2013 Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs). BSI,

CIRIA Rep R 149 (1995a) Protecting Development from Methane. Report 149, CIRIA, London.

CIRIA Rep R 150 (1995b) Methane Investigation Strategies. Report 150, CIRIA, London.

CIRIA Rep R 132 (1996) A Guide for Safe Working on Contaminated Sites. Report 132, CIRIA, London.

CIRIA C552 (2001) Contaminated land risk assessment. A guide to good practice (report no. C552).

CIRIA C665 (2007) Assessing the risks posed by hazardous gases to buildings CIRIA, London

CIRIA C681 (2009) Unexploded ordnance (UXO) A guide for the construction industry (C681)

CIRIA C785 (2019) Unexploded ordnance (UXO) risk management guide for land-based projects (C785)

CIRIA C758D (2019) Abandoned mine workings manual (C758D)

Contaminated Land: Applications in Real Environments (CL:AIRE) (2011) Definition of Waste Code of Practice (version 2).

Department of Environment Food and Rural Affairs (DEFRA) (2012) Environmental Protection Act 1990:Part 2A Contaminated Land Statutory Guidance (report no. PB13735).

Environment Agency (2000) Technical Aspects of Site Investigation. Report P5-065/TR, Environment Agency, Bristol.

Environment Agency (2002) Guidance on Monitoring Landfill Leachate, Groundwater and Surface Water. Report LFTGN02, Environment Agency, Bristol.

Environment Agency (2007) Evaluation of Models for Predicting Plant Uptake of Chemicals from Soil. Report SC050021/SR, Environment Agency, Bristol.

Environment Agency (2015) Guidance on the Classification and Assessment of Waste Technical Guidance WM3 (1st edition).European Union (1998) Drinking Water Directive (Council Directive 98/83/EC).

Land Contamination Risk Management (LCRM) Environment Agency October 2020 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm .

LQM/CIEH Ltd (2015) S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.

SoBRA (2017) Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater – Version 1.0.

The Water Framework Directive, (Standards and Classification) Directions (England and Wales).

World Health Organisation (2017) Guidelines for Drinking Water Quality (4th edition).

Britain From Above - https://britainfromabove.org.uk/en/image/WPW060399

http://www.warstateandsociety.com/Bombing-Britain

https://www.epa.gov/pfas/basic-information-pfas

Health and Safety Executive (2015) Construction (Design and Management) Regulations.

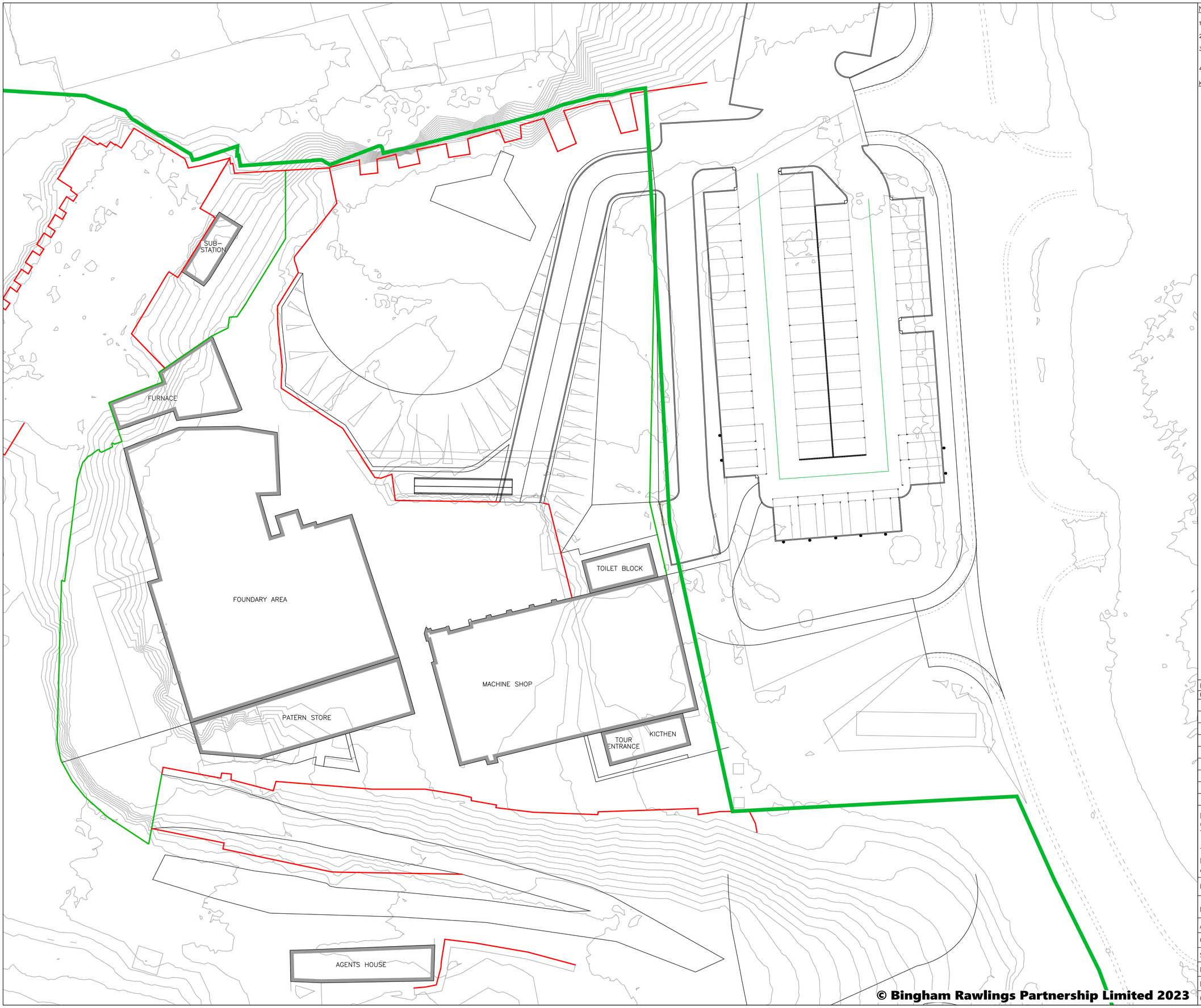
Coal Authority Interactive Map Viewer, http://mapapps2.bgs.ac.uk/coalauthority/home.html

BGS Geology of Britain Viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html

8 DEFINITIONS

AOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GQRA	Generic Quantitative Risk Assessment
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
ppm	Parts per million
ppmv	Parts per million by volume
SAC	Special Area of Conservation
SPZ	Source Protection Zone (see **Error! Reference source not found.**)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest

APPENDIX A - DRAWINGS



NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL LEVELS IN METERS UNLESS NOTED OTHERWISE ON DRAWING.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ENGINEER'S AND ARCHITECT'S DRAWINGS AND RELEVANT SPECIFICATION CLAUSES.
4. PLEASE REFER TO ARCHITECTS DRAWINGS FOR FINAL BUILDING LOCATION.

KEY

FOR TENDER ISSUE

Revisions.

Revision	Made by	Date	Checked	Description
C01	M.J	31.10.2023	I.R	UPDATED LAYOUT AND UPDATED TO TENDER ISSUE
P01	M.J	04.07.2023	I.R	FIRST ISSUE

Bingham Rawlings Partnership Limited
Consulting Civil & Structural Engineers
The Stables
1 Grosvenor Road Wrexham LL11 1BS
Telephone:(01978) 353522
Fax:(01978) 355177
e–mail : consult@brp2000.co.uk

b.r.p Bingham Rawlings Partnership Limited

Project	BRYMBO HERITAGE PROJECT
Drawing Title	PROPOSED SITE PLAN
Architect	TACP ARCHITECTS
Client	BRYMBO HERITAGE TRUST
Scale 1/250 @ A1	
Drawn M.Jones	
Date 21.06.2023	
Checked I.Rowlands	

4866|0002

Revision P01|C01

© Bingham Rawlings Partnership Limited 2023

APPENDIX B - UNFORESEEN GROUND CONTAMINATION

GroundSolve Ltd

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any "brownfield" site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination, and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected, contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of clayey Alluvium, or on 2000-gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept, and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:

    - re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
    - treatment of material on site to meet compliance targets so it can be reused; or

- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. Verification Report will be produced for the work.

Asbestos

Asbestos cement products and asbestos fibres have not been encountered in the soils at the site but based on the age of the Made Ground material containing asbestos could be expected to be encountered. If non-notifiable asbestos (e.g., chrysotile asbestos cement board) is encountered in excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore, it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on-site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on-site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE; and,
- Dust and fibre monitoring.

Potential mitigation measures that would be required include:

- Ensuring works are carried out by suitably trained and experienced personnel with working with asbestos;
- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and,

- Compliance monitoring.

Unexpected Tanks

No buried underground fuel storage tanks have been encountered during the site investigation works; however, there remains a low risk that tanks are present on-site. Should an underground tank be encountered, operations should cease in the area. Additionally, there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic recorded will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.

APPENDIX C - GUIDANCE FOR CLASSIFICATION OF SOIL FOR OFF SITE DISPOSAL AT A LANDFILL SITE

GroundSolve Ltd

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as "suitable for use" on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g., separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g., separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to 'dilute it' and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two-tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three-tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six-figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g., by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g., corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance 'Understanding the Landfill Directive' version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓
17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB's are hazardous			✓

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g., 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency's "Technical Guidance *WM3* Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste" (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally, some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of sites do not incur landfill tax which in the 2018/19 tax year is £2.80 for inactive waste (inert and some types of non-hazardous waste) and £88.95/Tonne for active waste (some types of non-hazardous waste and hazardous waste. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three-stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g., a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g., there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous, but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be is included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g., sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g., total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g., lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present

in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst-case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g., add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

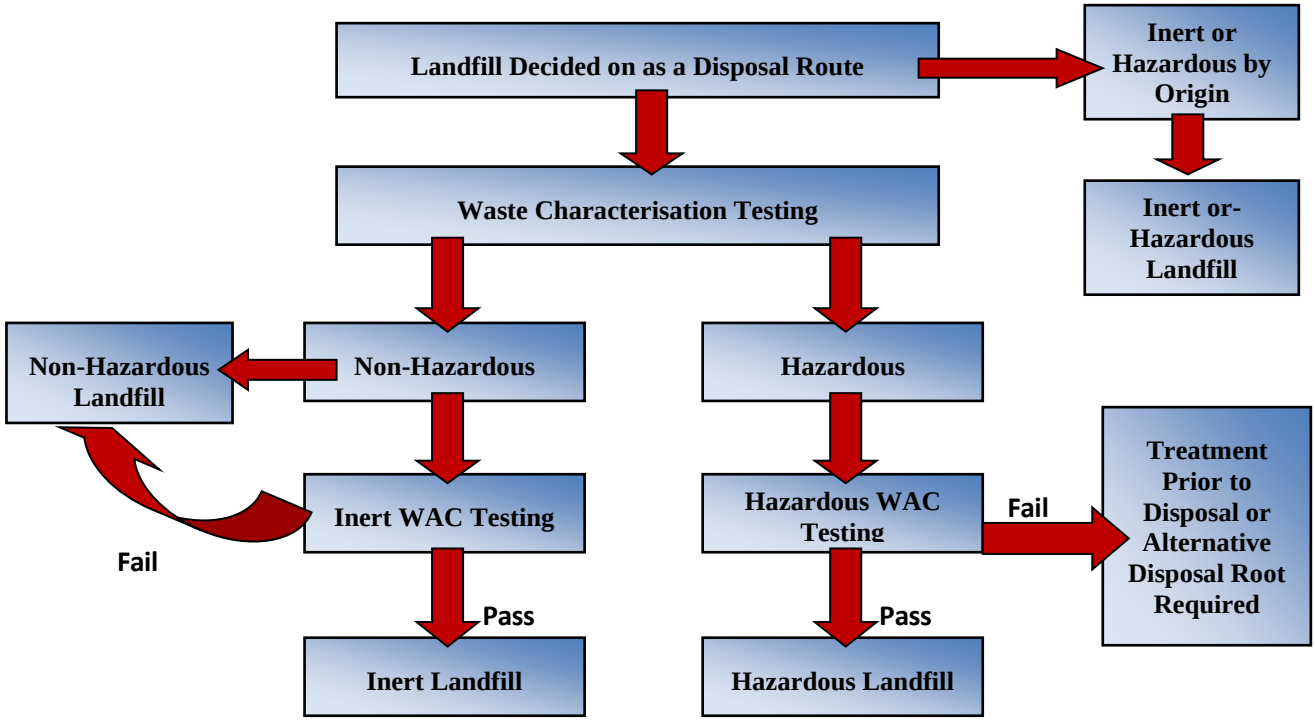
If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively, WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g., by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



Landfill Tax

It should be noted that HM Revenue and Customs (HMRC) classify wastes for tax purposes using a different scheme to the threefold landfill EU Landfill Directive scheme (i.e., the hazardous, non-hazardous and inert). HMRC have a two-fold system for landfill tax. The Standard Landfill Tax is currently £88.95/T and applies to all wastes unless they qualify for the reduced rate of landfill tax of £2.80/T. The wastes that qualify for the reduced rate of Landfill Tax are set out in The Landfill Tax (Qualifying Material) Order 2011 with supplementary information on the interpretation of these regulations in HMRS "Notice LFT1 – A General Guide to Landfill Tax" (May 2012) and HMRC Briefing Notes 15/12 and 18/12.

APPENDIX D – PREVIOUS THIRD PARTY REPORT

Contaminated Land
Air Quality
Environmental Audit

SMITH GRANT Environmental Consultancy LLP

Partnership No: OC 300776

Stori Brymbo
TAITH O 300 MILIWN O FLYNYDDOEDD
A 300 MILLION YEAR JOURNEY

CRONFA DREFTADAETH HERITAGE FUND

BRYMBO STEELWORKS HERITAGE AREA:

LAND CONTAMINATION REVIEW

For: BRYMBO HERITAGE TRUST

November 2019

R2762-R01-v2-Final

Smith Grant LLP, Station House, Station Road, Ruabon, Wrexham, LL14 6DL
tel: 01978 822367 fax: 01978 824718 e-mail: consult@smithgrant.co.uk web: www.smithgrant.co.uk
Members: K E Hawkins (Chairman), B J Thomas, A F Smith, D Wayland

DOCUMENT CONTROL SHEET

Report Title: Former Brymbo Steelworks, Brymbo, Wrexham: Land Contamination Review

Client: Brymbo Heritage Trust

Report Reference Number: R2762-R01

Issue Final

Version: V2

Report Date: 25 September 2019

Signed for Smith Grant LLP

	Name	Position	Signature	Date
Author	M Jones BSc, MSc	Graduate Consultant		18.11.2019
Reviewer	B J Thomas BSc, MSc, CIWEM, C.Env SiLC 	Partner		18.11.2019

Document Revision Record:

Version	Report Status	Date	Details of Revision
2	Draft	03.10.2019	Surface water results of reed beds
2	Final	18.11.2019	

This report has been prepared by Smith Grant LLP for the sole and exclusive use of Brymbo Heritage Trust. All reasonable skill, care and diligence has been exercised within the terms of the contract with the client. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. This report may be relied upon or transferred to any other parties only with the express written authorisation of Smith Grant LLP, such consent not to be unreasonably withheld or delayed. If any Third Party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty or care of skill.

Smith Grant LLP reserves the right to alter any of the foregoing information in the event of new information being disclosed or provided and in the light of changes to legislation, guidelines and responses by the statutory and regulatory authorities.

FORMER BRYMBO STEELWORKS, HERITAGE AREA:

LAND CONTAMINATION REVIEW

CONTENTS

1. Introduction
2. Information Sources
3. Development History and Current Status
4. Site Characterisation
5. Previous Site Investigations
6. Planned Future Use
7. Site Conceptual Model
8. Conclusions
9. Recommendations

DRAWING

D01 Site Plan, Features & Photograph locations
D02 Recorded Site Investigation and Sampling Locations

APPENDICES

A Photographic Record August 2019
B Surface Water Monitoring results & Analysis

1. Introduction

1.1. Brymbo Heritage Trust (BH) has instructed Smith Grant LLP (SGP) to undertake a review and update of previous reporting on a parcel of land associated with the former Brymbo Steelworks. comprising historic buildings and infrastructure and extensive external areas.

1.2. The former steelworks site has been divided into a number of discrete development modules. This report focuses on the Heritage area based on the site boundary provided by BH as indicated on R2762-D01. Site details are:

Table 1.1: Site Details

Address	Former Brymbo Steelworks, Brymbo, Wrexham, LL11 5AX
National Grid Reference	329340, 353510
Local Authority	Wrexham County Council
Site Areas	Heritage Area: Approximately 4.8 Ha
Current Use of Sites	The site comprises of hardstanding concrete, old structures, and public spaces.
Proposed Use	Mixed use as a visitor attraction, social amenity space, retail and commercial units and community hub.

Figure 1.1: Site Location



Reproduced with the permission of the Ordnance Survey @Crown Copyright Licence No. 100005799

1.3. This report contains a review of factual and interpretive information obtained during the wider reclamation/remediation of Brymbo Steelworks, supplemented by a walkover and limited supplementary investigation undertaken by SGP in accordance the site investigation requirements. This report contains a qualitative risk assessment with respect to future liabilities development constraints associated with ground contamination only.

Information Sources

1.4. The principle sources of information consulted in the preparation of this report include:

Table 2.1: Information Sources

Date and reference	Author and source	Purpose and information content
Topography, geology, hydrogeology and hydrology		
http://mapapps.bgs.ac.uk [Accessed August/September 2019]	British Geological Survey.	distribution of geological units at surface including drift and artificial deposits, faults and mineral outcrops
https://www.ordnancesurvey.co.uk/osmaps/ [Accessed August/September 2019]	Ordnance Survey (OS), Explorer Map, 1: 10,000	general mapping information including structures, boundaries, ground features, water features etc.
Historical data		
Satellite imagery	Various	Recent historical features
Historical Maps (various)	Ordnance Survey	Historical mapping at 1:2,500, 1: 10,000 and 1: 10,560 from 1848 onwards.
Information Review		
https://magic.defra.gov.uk/MagicMap [Accessed August/September 2019]	Defra	web-based interactive map containing information on nature conservation areas, aquifer designations, source protection and nitrate vulnerable zones.
Heritage Module – Contamination Certification Report (Ref: R754-R06 FINAL) November 2009	Smith Grant LLP	Collated and presented available information on the contamination status of the Heritage Module and outline any necessary remediation requirements appropriate to the proposed future uses of the module.
Brymbo Steelworks Site Contamination Assessment (Ref: R31.R07). September 1995	Smith Grant LLP	Collated and presented available information on the contamination status of the Heritage Module and outline any necessary remediation requirements appropriate to the proposed future uses of the module.

1.5. Site Inspections

1.5.1. A reconnaissance site inspection was undertaken by B Thomas, SGP Partner on 28th August 2019.

1.5.2. A round of surface water monitoring was undertaken by B Thomas, SGP Partner on 05th September 2019.

2. Development History and Status

2.1. Historical Development

2.1.1. A summary of significant features, developments and land uses shown on historical Ordnance Survey maps is provided in Table 3.1 below:

Table 3.1: Summary of Development History

Map	Site	Surrounds *(all distances are approximate)*
1873 1:2,500	The site is part 'Brymbo Ironworks'. The area comprises of 3 main areas: Central Heritage Area: There are multiple buildings in this area relating to the ironworks, with multiple mineral lines running in from the west into the upper area. There is a large building (presumably part of what is now known as the ironworks building) in the centre of the site and the agents house stands on the southern edge of the upper area. Blast Pit Area: A few buildings and coal and iron mining shafts are present in the upper area and a mineral line (running W-E) and slope are present in the lower area. Duck Pond Area: A mineral line enters the southwest corner of this area	The surrounding area is dominated by the Ironworks. The further surrounding area is mainly agricultural land use with scattered residential properties and roads. North: A gravel pit is approximately 200m to the north and the village of Brymbo is directly adjacent to the northern edge of the site. This includes residential properties, a post office, a well (250m), a church, and 2 chapels. South: The 'Wonder Pit' is labelled 200m to the southwest. There are 2 pits 260m to the south, 6 coal shafts (260m, 260m, 500m, 520m, 670m, 750m, and 1.1km), 'Brymbo Hall' 280m to the south, a reservoir 700m to the southwest, the village of 'The Lodge' 600m to the southeast, a 'Safety Fuse Works' 900m to the south, and 'Broughton Colliery' 1.5km to the southeast. Wrexham is approximately 4.5km to the southeast. East: The 'Great Western Railway: Vron Branch' runs directly to the east of the site boundary. A large pit is adjacent to the railway. 3 mining shafts are located approximately 600m to the east/southeast. A school is located 620m to the east. West: There are multiple mining shafts approximately 150m, 300m, and 480m to the west. 'Brymbo Smelt Works' is located 540m to the northwest, which includes a large pond, a smelt pit (570m), 3 more shafts (620m, 695m, and 700m), and some buildings (700m). There is a large pond approximately 790m to the southwest.
1879 1:10,560	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: No significant change. East: No significant change. West: A large pond has appeared 500m to the southwest.
1899 1:2,500	The site has changed name to 'Brymbo Steel & Iron Works'.	North: The village of Brymbo has increased in size, with more residential properties.

Map	Site	Surrounds *(all distances are approximate)*
	Central Heritage Area: A few of the mineral lines in the upper area have disappeared and some chimneys has appeared in the lower/main heritage area. Blast Pit Area: The previous buildings in this area have been demolished and new ones have been built. Only one shaft is indicated in the upper area. More mineral lines run through the lower area from the west and link to the Wonder Bank Pit to the southwest. Duck Pond Area: A mineral line starting at the western point of this area, runs through the lower area into the blast pit area. The upper area is open grassland.	South: A tennis lawn is now adjacent to the southern site boundary. A well has appeared 230m to the south. A phosphate works has appeared 900m to the south, close to the 'Safety Fuse Works'. Additional train lines have been constructed including the 'Brymbo Branch' of the 'W.M. & C.Q.R'. A football ground has appeared 1 km to the south. East: A large building has been constructed in the large pit adjacent to the railway. Brymbo station is labelled adjacent to the south of the pit, and 290m to the east. 'Black Lane Colliery' has been labelled 620m to the east, just north of the school. This includes a pit, a shaft, and a building. West: The Wonder Bank Pit has undergone significant change with multiple mineral lines entering the site from the south and the east. The large pond to the west has now been labelled a reservoir and a smaller reservoir has appeared across the road adjacent to the large reservoir. 'Brymbo Smelt Works' is now labelled 'Carbon Works'.
1900 1:10,560	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: An old quarry has been labelled 300m to the north. South: There is now a pond next to the football ground (1.1km). East: No significant change West: 500m north of the carbon works to the west, 'Cae-llo Brick Works' has appeared, including 5 old mining shafts approximately 630m from the site.
1912 1:2,500	Central Heritage Area: More mineral lines enter the area from the east. Blast Pit Area: A few more buildings have been constructed in the upper area around the shaft. A sawmill has appeared to the east of the shaft with a mineral line running from the duck pond area to the nearby Wonder Bank Pit. Duck Pond Area: The upper area is open grass and woodland. The lower area remains a mineral line.	North: No significant change. South: The football ground has gone. East: No significant change. West: The Carbon Works is now labelled as 'disused'.
1914-1915 1:10,560	Central Heritage Area: No significant change. Blast Pit Area: No significant change.	North: No significant change. South: No significant change. East: No significant change. West: No significant change.

Map	Site	Surrounds *(all distances are approximate)*
	Duck Pond Area: No significant change.	
1938-1954 1:10,560	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: Some residential properties have been constructed 110m to the northwest. South: No significant change. East: No significant change. West: No significant change.
1962-1963 1:2,500	Central Heritage Area: The 'machine shop' has been constructed to the east of the ironworks building and some large buildings have been constructed in the centre of the lower/main heritage area. A row of chimneys to the north of the lower area has also been constructed. Blast Pit Area: Two buildings to the adjacent to the largest colliery building have been demolished and the shaft is now labelled 'disused'. The sawmill and the mineral line running to the Wonder Bank Pit are no longer indicated. Duck Pond Area: No significant change.	North: More residential properties have been constructed 300m to the northwest. South: The football ground is now a 'sports ground' and the pond has gone. East: The railway adjacent to the eastern site boundary is now labelled 'mineral railway'. The Black Lanes Colliery is not labelled 'Mine (Disused)'. West: The Carbon Works buildings have disappeared. Only the large reservoir remains.
1963-1964 1:10,560	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: No significant change. East: No significant change. West: No significant change.
1967 1:2,500	Blast Furnace Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: Further residential development to the northwest. South: A large steelworks building has been constructed 100m to the south. East: No significant change. West: No significant change.
1974-1976 1:10,000	Blast Furnace Area: No significant change. Blast Pit Area: No significant	North: No significant change. South: Brymbo Hall is no longer present and the area from the southern site boundary to the sports ground (approx.

Map	Site	Surrounds *(all distances are approximate)*
	change. Duck Pond Area: No significant change.	1km) is now an opencast mine. A substation has appeared 300m to the southwest, next to the opencast mining area. East: The mineral railway running directly adjacent to the eastern site boundary is now labelled 'dismantled'. West: The Brick Works has disappeared.
1976-84 1:2,500	Central Heritage Area: The row of chimneys to the north of the lower area has disappeared. Blast Pit Area: A few more buildings have been demolished. Duck Pond Area: The mineral line that ran to the western point, has reduced to about half the previous length.	North: No significant change. South: No significant change. *Partial mapping.* East: No significant change. West: No significant change.
1987 1:10,000	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: No significant change. East: No significant change. *Partial mapping.* West: No significant change.
1991-1992 1:10,000	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: A large building has been constructed 500m to the south. East: No significant change. West: No significant change.
2006 Satellite Imagery	Central Heritage Area: Most of the buildings have been demolished apart from the buildings now known as the machine shop, the ironworks, the pattern makers workshop, and the agents house. Blast Pit Area: The area is overgrown with trees and the vegetation. The remains of the old colliery building are visible along the southern edge. Duck Pond Area: The area is overgrown with trees and vegetation, however, there is a small structure visible in the centre	North: All the buildings relating to the steelworks have been demolished South: All the buildings relating to the steelworks have been demolished. Residential properties are beginning to be constructed 770m to the south. East: The largest building has been demolished and is now open land. West: The larger reservoir is now labelled 'Brymbo Pool', and the smaller reservoir has disappeared.

Map	Site	Surrounds *(all distances are approximate)*
	of the area.	
2007 Satellite Imagery	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: More residential properties are being constructed to the south. East: No significant change. West: No significant change.
2009 Satellite Imagery	Central Heritage Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: More residential properties are being constructed to the south. East: No significant change. West: No significant change.
2012 Satellite Imagery	Blast Furnace Area: No significant change. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: More residential properties are being constructed to the south. Plant life is beginning to return to the old steelworks site. East: No significant change. West: No significant change.
2018 Satellite Imagery	Central Heritage Area: The original ironworks building has been demolished with a few of the iron structures remaining and the printmakers shops roof has been removed. A few temporary buildings have appeared in the main heritage area (north of the machine shop), presumably part of Brymbo Heritage Trust. Blast Pit Area: No significant change. Duck Pond Area: No significant change.	North: No significant change. South: More residential properties have been constructed to the south. East: The spine road has been constructed to the east, connecting the village of Brymbo to the new residential developments to the south. West: No significant change.

2.1.2. Present Land Condition

2.1.3. A summary of existing significant features, recent activities and land uses shown on contemporaneous aerial photography, site inspections and anecdotal evidence is provided in Table 3.2 below. The locations of specific features of interest are provided in drawing D01 which also gives the locations of contemporary photographs of the site and features of interest provided in Appendix A.

Table 3.2: Present Land Condition

Site Description	The site is conveniently split into 3 main adjoining areas: The Central Heritage Area: open, level land to the frontage on Phoenix Drive behind which are the main historical buildings and structures including the blast furnace, forge, machine shop and workshops, and housing a number of temporary cabins; the site forms an amphitheatre rising on all sides but the east via a series of steps, embankments, cuttings and large retaining walls with smaller middle and upper levels The Blast Pit Area: behind and to the west of the uppermost level of the Central Heritage area, largely level in the north and rising to the south up an upper level comprising a steep, wooded bank which contains the historical Blast Pit coal mine, beyond which the ridge drops down to the Haul Road. The Duck Pond Area: to the west of the blast pit, the duck pond area comprises a large, open level plateau which extends from the top of the Haul Road, southern part of Blast Pit to the back gate of the site on Blast Road and is bounded by the Wonder Bank to the south. This is separated from the lower part of the Duck Pond area by a wooded, steep embankment which slopes down to the north onto the track bed of a historical railway line extending back east towards the northern Blast Pit and upper Central Heritage areas.
Access	The Central Heritage area is accessed off Phoenix Drive by one of two gates onto the open car park area and a second gate into the main, lower area of historical buildings. In the south and access track leads between the Machine Shop and Forge/Workshop up to the middle and upper Central Heritage area, from which access is gained to the Blast Pit and Duck Pond areas. The Duck pond area can also be accessed from gates off the Haul Road in the southeast and the junction at the top of Blast Road/bottom of Brake Road in the northwest.
Boundaries	The East of the site is separated from Phoenix Way by strip of open land currently used as a car park, which is fenced and gated at the pavement. The North of the site at the Central Heritage Area is bounded by the large retaining wall onto the adjacent enterprise Centre; the north of the Blast Pit and Duck Pond Areas front blast road with steel palisade fencing. The western site boundaries are on the Duck Pond Area and comprise a mix of steel palisade bounding private gardens and mesh fencing bounding a public footpath running along the boundary with the Wonder bank.

	The Southern Boundary is largely open onto the Haul Road to the south of the Blast Pit Area and the Fossil Forest to the south of the Central Heritage Area.
Services / Wayleaves	No utility plans have been obtained; however, it is understood the Machine Shop and a number of the temporary buildings in the lower Central Development Area have connections for gas and electricity and are served by a surface water drainage system comprising a series of connected gulleys accepting falls from the concrete surfacing and accessed by a number of manhole covers. One series of drains accepts flow from the Foundry Adit, a historical mine drain within the Ironworks diverting flow via a series of pipes and ditches to the surface water drains along Phoenix Way. During times of high flow these reportedly overflow across the site surface. Other relict railway track and land drains are anticipated to cross the site, generally flowing in an easterly direction. In the lower part of the Duck Pond and Blast Pit areas a series of pipes and surface water flows was observed which feed and discharge a pond feature believed to be a newt habitat.
Rights of Way	SGP understand that no rights of way cross the site, the site is mainly secure and informal access is not readily obtained. The site is accessed by the public on a limited number of open days by guided tours however unsupervised access is not permitted.
Structures	Most of the site buildings are present in the lower Central Heritage Area, excluding temporary and minor structures and cabins these comprise the Machine Shop – a large habitable brick building, the pattern makers workshop – a derelict stone building in poor condition with no roof, a series of gantries, cranes and other relict infrastructure associated with the forge, and the original stone blast furnace. To the south, west and east sides of the lower central Heritage area, and to the west and north of the middle Central Heritage area a series of retaining structures of various scales are present. In the south of the upper Central Heritage area a stone building, formerly the agent's (supervisor's) with a metal sheeting roof is present. In the Blast pit area, a number of derelict and decaying brick buildings associated with the former pithead remain in the south, the shafts themselves are not believed to have been structurally capped. No buildings, apart from two small brick structures and a large coal hopper and chute adjacent to the historical track bed are present in the northern parts of the Duck Pond area or the Blast Pit area.
Surfaces / Vegetation	Within the Central Heritage area, the site is surfaced by a mixture of granular aggregate and historical hardstanding comprising a mixture of concrete slabs and tarmac. The hardstanding is generally poor condition, uneven and degraded. The other parts of the site contain occasional areas of hardstanding, generally associated with the footprints of demolished buildings or process/ storage areas but are, for the most part vegetated.

In all parts of the site where ground does not have a surface cover of vegetation, or hard surfacing, a mixture of made ground materials were visible, the following records some of the typical materials exposed



Limestone gravel over running areas



Soil with fine gravel of blast furnace slag



Mix of ash, brick, stone and clinker



Limestone gravel over running areas



Gravel of coal



Gravel of coke, breeze, clinker and slags

2.2. Historical Development Summary

2.2.1. Brymbo Steelworks closed in 1990 after some 200 years of iron and steel production; the Heritage area was the oldest part of the steelworks and had not been used for production for many decades, although was still actively used for workshops, repair and storage. Following closure, much of the above ground structure and plant were cleared over the remainder of the site. The site was subsequently acquired from United Engineering Steels Ltd. (UES) by Brymbo Developments Limited (BDL), specifically to undertake the reclamation and redevelopment of the site.

2.2.2. Details of the original reclamation scheme were submitted to Wrexham County Borough Council (WCBC) in December 1995 with Planning Approval being granted in November 1997 (ref: CB00016). The overall scheme has evolved since the preparation of the original application in on-going consultation with all the relevant bodies (WCBC, Local Liaison Committee, Environment Agency Wales (EAW), Welsh Development Agency (WDA) etc). Reclamation works commenced on the main site in October 2003.

2.2.3. The reclamation and redevelopment works were undertaken by BDL. SGP has been retained as Environmental Consultant by BDL since 1995 and information and data obtained by SGP have been used in the design of the reclamation strategy for the overall site, in relation to potential environmental impacts during the works and on completion.

2.2.4. The role of SGP during the reclamation of Brymbo Steelworks included the placement of a full-time chemist on site to observe and monitor activities and collect samples as required and in accordance with environmental monitoring plans and agreements. Specific activities included:

- identification of the nature and extent of contamination across the site;
- provision of advice on appropriate reclamation and remediation measures across the site;
- deposition and airborne dust monitoring;
- controlled waters monitoring;
- noise monitoring;
- liaison and correspondence with the relevant regulatory authorities as necessary;
- additional sampling, analysis and monitoring as required across the site;
- production of Contamination Certification Reports for the individual reclamation modules for provision to the relevant parties.

2.2.5. During the main reclamation and remediation works over the rest of the steelworks site the Heritage area remained largely undisturbed as contained several buildings of historical value and a number of ecological buffers. Parts of the upper Central Heritage Area, Blast Pit Area and Duck Pond Area were used for temporary materials and plant storage, setting down and to house certain materials reclaimed from the rest of the site. The Haul Road was created to the south of the area to facilitate access for heavy plant form the main earthworks packages to the northern areas and the adjacent Wonder Bank.

2.2.6. The only contamination remediation works undertaken within the heritage area was the diversion of drainage from the Foundry Adit to a ditch containing crushed concrete as a medium-term means of balancing the pH of the water (which was acidic and metalliferous) before it was discharged into the temporary site drainage system and eventually the local surface water drainage network.

2.2.7. Since 2013, BH have been planning and designing the new visitor attraction planned to be built by 2023. They host open days on site focusing on different aspects such as; ecology, historical significance, the adjacent Fossil Forest, and the railway tracks. Other mixed educational, tourism, commercial and social enterprise uses are planned for the site in the future.

3. Site Characterisation

3.1. The physical setting of the site is summarised below:

Table 4.1: Environmental Setting

Topography	According to contemporary Ordnance Survey mapping, the site is relatively level at an elevation of approximately 205m Above Ordnance Datum (AOD).
Geology	BGS, historical OS mapping, the previous reports, and site observations indicate the potential ground, conditions to be: Made ground: Is anticipated to be at depth and surface level, due to the historical development history. The depths of made ground are expected to vary significantly, particularly where embankments, cuttings, retaining structures and buildings / plant are present and will comprise a mixture of re-worked natural materials, colliery spoil and steelworks waste. Superficial Deposits: BGS mapping provides no data for superficial deposits beneath the site. Bedrock: BGS mapping shows the underlying bedrock to be Cefn Rock – Sandstone. Faults: - The Brymbo Fault is mapped as running roughly NNW-SSE across the centre of the main site, crossing the western side of the Blast Furnace area. The fault has been seen in the opencast workings as a narrow well-defined break and throws down the strata by about 140m to the west. On the west side of the fault the Cefn Rock sandstone outcrops whilst to the east are the typical sequences of Coal Measures strata. Cefn Rock outcrops can be seen above the Blast Pit, the Old Foundry and the Agent's House.
Hydrology / Drainage	Surface infiltration of rainwater will be via runoff from hardstanding in the main heritage area; however, this is damaged in places so will permit infiltration of rainwater into the underlying fill. The former track bed crossing the most northerly parts of the Duck Pond and Blast Pit areas is prone to flooding, as are areas of the lower Central Heritage Area. The culvert / drain which accepts flow from the Foundry Adit is also prone to overtopping during periods of high flow. The drainage from the site enters the modern network of drains associated with Phoenix Way and enters the Lodge stream to the east of the main site at the bottom of the Eastern Slopes Area.
Hydrogeology / Groundwater	The Environment Agency (via the Defra Magic Map web application) shows that the bedrock underlying the site is classed as a Minor Aquifer and the superficial deposit is unproductive. The site is not in an area of aquifer vulnerability and not in any Source Protection Zones.

	Groundwater within the main site and surrounding area was sampled and assessed prior to the on-set of reclamation activities (Summary Review of Baseline Water Quality Prior to Commencement of Works, October 2003, SGP, Ref: R175-R13). The groundwater from remaining boreholes across the site was subsequently sampled in 2004, 2005 and 2006 and reported in the annual reports. All results were summarised in the 2006 Annual Water Quality Report. The groundwater underlying the main site was found to be of generally poor quality, both due to the natural poor quality of groundwater within Coal Measures and arising from the long industrial history of the site. The EAW previously agreed that the groundwater beneath and around the site is not considered a sensitive receptor in its own right and is not likely to be used as a supply of potable water in the foreseeable future. Groundwater flow is locally influenced by the numerous mineworkings present beneath he site and the surrounding area, which are known to drain variously to the north via old mine workings and mine drainage discharges to the Afon Cegidog in the Ffrith valley, to the east via old mineworkings to mine discharges to the Afon Alun near Cefn-y-Bedd or to the south via the Tan-y-Fron Adit and discharging to the Afon Gwenfro.
Mining	The former Brymbo Colliery (Blast Pit) is located in the center of the Heritage Area and comprised two shafts. Information provided by BDL indicated the shafts were 169m and 171m deep. The shafts were sunk in the 1840s and closed in 1914. The shafts have been infilled to 60m bgl with water inflows recorded at 30m bgl. The plan also shows four recorded adits within the area located along the side of the former sidings in the Blast Pit area; none of these are now visible. Another adit, the Foundry Adit, is located within the Old Foundry and presently continues to discharge mine drainage water on an irregular basis.
Landfill	Natural Resources Wales mapping indicates that the wider site is a historical landfill, referred to as the Works Bank as the Steelworks held a license to tip waste materials anywhere within their boundary. This was surrendered as part of the programmed of remediation works in 2008.
Nature Conservation & Protected Areas	The closest special designation relating to nature conservation (as shown by the Defra Magic Map web application) is 'Brymbo Fossil Forest' Site of Special Scientific Interest, immediately adjacent to the southeast corner of the heritage area. The previous report mentions the Duck Pond Area being a Great Crested Newt habitat; and extensive Newt Fencing is present around various parts of the site with an established pond present in the Duck Pond Area. The blast furnace, cast house and foundry structures within the Central Heritage area are scheduled ancient monuments and the former Agents house has Grade 2 listed status.

4. Previous Site Investigation Results

4.1.1. Parts of the Heritage Area were investigated as part of the overall steelworks site investigation in 2007 by SGP, 'Brymbo Steelworks: Heritage Module, Contamination Certification Report', November 2009 (ref: R742-R06). This review refers to data collected investigation undertaken in 1995 by SGP, 'Brymbo Steelworks Site Contamination Assessment, September 1995, ref: R31.R07'.

4.2. Report observations and area description:

4.3. The Heritage Area effectively comprises four distinct areas of land, referred to as:

- the Blast Furnace area;
- the Blast Pit area;
- the Duck Pond area; and
- part of the access road to the base of the Wonder Bank (The Haul Road).

4.3.1. The area termed 'Blast Furnaces area' within both the SGP 1995 contamination report and the planning permission relating to the overall site redevelopment also included the former coke ovens area (referred also to as the Upper Blast Furnace Area), located to the north and at a raised elevation above the blast furnaces. This area forms the North West Development Module (NWDM) and has been redeveloped into the Brymbo Enterprise Centre. The NWDM has since been subject to separate contamination investigations and was remediated in 2004. The results for this area are therefore excluded from this assessment and the Blast Furnace Area, excluding the NWDM is now referred to as the Central Heritage Area.

4.3.2. The hillside rises to the west and south of the Central Heritage Area up to the Blast Pit area. This comprises the former Brymbo Colliery with two shafts (the Blast Pits), former colliery buildings and former railway sidings and tramways located on a series of levels. The borehole sunk to provide water supply to the site is also located within this area, referred to as the Supply Well. The Agent's House (a Grade II listed building), is located within the Blast Pit area to the immediate south of, but at a higher elevation than, the Blast Furnace area.

4.3.3. The northern section of the Blast Pit area is at about 218m AOD and includes a series of ponds. The area rises up on the south side to form an area into which an access road to the Wonder Bank has been constructed adjoining the former Ty Cerryg opencast coal site at about 230m AOD. A former railway siding runs northwest from the pit area alongside Blast Road ending in the northwest corner of the Heritage Module. The siding is steep sided on both sides and is about 4m below the height of Blast Road. The hillside above the siding is heavily wooded.

4.3.4. The area termed 'Blast Pit' within the SGP 2007 and 1995 reports also included a stretch of land to the southeast consisting of part of an infilled quarry and site buildings. This area was excavated as part of creation of the access road to the Wonder Bank and the Fossil Area, and is referred to as the Haul Road, forming the southern boundary to the Blast Pit Area. Following excavation of the road, which exposed colliery spoil, the slopes have been hydroseeded and the majority of the slopes are now vegetated.

4.3.5. The gradient continues to rise to the west above the Blast Pit Area to the Duck Pond Area. The majority of this area is level at about 234m AOD and is bounded by Ty Cerryg to the southeast and the Wonder Bank to the southwest. A public footpath runs between the Duck Pond area and the Wonder Bank.

4.3.6. The Duck Pond area contained an old coal storage area and railway sidings and is now overgrown with scrub. A coal hopper and chute remain which originally discharged onto a siding at Blast Pit level. A series of ponds have been created within this area to provide a Great Crested Newt habitat and to which surface water run-off from the Wonder Bank is directed. During these works hardcore surface cover was placed across some of the area.

4.3.7. The areas have not substantially changed since the 2009 report, and the descriptions remain largely relevant. SGP understand that minor drainage works, the placement of clean stone aggregate to surfaces of running and storage areas and works to stabilise buildings and structures only have taken place.

4.4. Fieldwork & Ground Conditions

4.4.1. Previous investigations comprised identification of the general contamination levels in the Heritage Area through the excavation of trial pits and collection of soil and water samples.

4.4.2. In addition to the investigations specifically targeted within the Heritage Area, a series of surface water, groundwater and adit monitoring exercises were undertaken across the site, both prior to and during the site reclamation works, which have included collection of water samples from the boreholes, ponds, the Foundry Adit and the Furnace Culvert within the Heritage Area.

4.4.3. The locations of all trial pits, boreholes, surface soil and water samples as of 2009 are shown on Drawing D02.

Central Heritage Area

4.4.4. At the time of the SGP investigation in 1995 the area included the old foundations and buildings. Access to much of the area was restricted by the structures present and existing services and hence investigations within, or in close proximity to, the area of interest were restricted to the installation of 2 boreholes (BFB1 and BFB2) to a maximum of 12m. They encountered made ground comprising metal slag, ash and concrete to about 8.5m bgl underlain by possible

bedrock.

4.4.5. To supplement this earlier data, additional trial pits were excavated within the Central Heritage Area in March 2005. The work comprised the excavation of 3 trial pits (HA1-HA2, HA5) and collection of 3 soil samples. Trial pits HA1 and HA2 were excavated on the middle level within the Blast Furnace area. A concrete slab base was encountered in HA1 at 0.7m preventing further excavation whilst HA2 encountered concrete and steel beams at 2.9m. Both trial pits encountered variable made ground of sandstone and limestone ballast, scrap metal, pipes, bricks, timber and cable. Trial pit HA5 was excavated in the lower level and encountered variable made ground of metal slag, bricks and timbers. It was not possible to extend the trial pit beyond a maximum depth of 3m due to obstructions.

Blast Pit area

4.4.6. Investigations in 1995 in the Blast Pit area comprised the excavation of 2 trial pits in the upper level (BP1 and BP2) to depths of about 3m. A third trial pit, BP3, was excavated within the former quarry area to the south of the Heritage Module boundary, close to the Ty Ceryg opencast coal site. BP1, located to the rear, and at the upper level of the old foundry and joiner's shop, encountered sand with shale fragments underlain by ash with brick to 2.0m bgl. The made ground was underlain by boulder clay to at least 3.1m. BP2, however, encountered more variable fill material with layers of slag, refractory bricks, clayey ash underlain by colliery shale graduating into ash to at least 3m bgl. Natural ground was not reached. The trial pit excavated within the infilled quarry to the south (BP3) confirmed the presence of extensive colliery waste in this area.

4.4.7. Additional investigations within this area in 2005 comprised the excavation in the upper level of 1 trial pit (HA3). HA3 was excavated in the vicinity of the earlier BP1 and encountered coal and shale fragments underlain by sandstone and ironstone blocks with sand and gravel to a depth of 3.2m (possibly natural ground).

Duck Pond Area

4.4.8. The 1991 NEC investigation comprised the excavation of 8 trial pits (BM1-8) to depths of about 3m. At the time of the investigation the area was flat and largely devoid of vegetation, the site surface comprising a thin patchy veneer of coal with slag and coke.

4.4.9. The area was generally underlain by an ash and slag fill to depths of 0.1-0.4m. This was generally underlain by slag gravel and cobbles (partially cemented in areas), further underlain by an ashy clay fill with occasional coal/coke, burnt shale, masonry, glass, wood and metal to depths varying between 1.0m (BM6) and >3.5m (BM1 and BM3).

4.4.10. Natural ground was encountered in BM2, 5, 6 and 8 at depths of 1.0 –2.15m consisting of silty/sandy clays with occasional gravel (boulder clay). Sandstone and mudstone bedrock were encountered in BM5 and BM6 at 2.6m-3.0m under the glacial deposits.

4.5. Soil Sampling & Analysis

4.5.1. Various phases of investigation have therefore included analysis for different suites of contaminants, all selected using a risk-based approach for the types of contamination characterised as widespread within the former steelworks prior to remediation / reclamation. The sample locations are provided in Drawing D02.

Blast Furnace Area

4.5.2. A total of 4 soil samples were collected in 1995 and submitted for comprehensive analysis. A further 10 surface soil / residue samples were collected in 2005 from within the former foundry building including sand, powder and wall coatings. All the soil samples were submitted for chemical analysis to Alcontrol Geochem for a range of determinants.

4.5.3. A selection of the samples was also submitted for leachate analysis; these results are discussed in the surface/ground water results assessment.

Blast Pit Area

4.5.4. A total of 5 soil samples were collected in 1995 and submitted for comprehensive analysis. further collection of 3 soil samples were taken in 2005 for comprehensive chemical analysis.

Access Road

4.5.5. 3 near-surface soil samples (TP070306WS6-8) were collected from the slopes of the access road located within the Heritage Module. A further 2 near-surface soil samples (TP070306WSROAD1-2) were collected from the road.

Duck Pond Area

A total of 20 soil samples were collected and submitted for comprehensive analysis by NEC in 1991.

4.5.6. In order to update the assessment, the results are compared to updated assessment criteria. The planned use of the site does not correspond exactly to any published Generic Assessment Criteria for soil contaminants. However, is likely to involve, sporadic, low intensity exposure by visitors, so values for Public Open Space, away from residential properties and appropriate for public parks have been adopted. Not all of the analysis suites or determinands are compatible with these criteria. Where total concentrations for groups of contaminants are given, a qualitative approach is adopted with discussion as to whether the results are likely to indicate exceedances

4.6. The following table shows the summary of all the soil analyses undertaken from 1991 - 2005 within the Heritage Area.

Table 1: Summary of 1991 - 2005 Soil Analysis

Determinant	Central Heritage Area		Blast Pit Area	Duck Pond Area	Haul Road	Screening Soil Standard adopted and concentration		Exceedances
	Fill Material	Surface Residues						
	(mg/kg or indicated)							
No. of samples	6	12	8	20	5	S4UL POS2	S4UL Commercial	
Arsenic	10-58	<1-27	5-57	7-146	<1-1	170	640	none
Boron (Water Soluble)	<0.8-1.9	<1-6	<1-5.5	na	<1-2	46,000	240,000	none
Cadmium	<1-14.5	<1-4	<0.5-1.3	0.5-21	<1	532	190	none
Chromium	370-3,269	4-9,545	29-7,900	na	<0.3-281	33,000	8,600	none
Hex Chromium	<0.3-1.3	<0.3-1.7	<0.3-<15	na	<0.3-<6	220	33	none
Mercury (inorganic)	<0.1-<1	<1	<0.1-<1	na	<1-1	240	1,100	none
Nickel	15-480	3-49	30-2,000	31-4,028	31-130	800	980	4 (1 x BP, 3 x DP)
Lead	64-1,400	4-341	23-810	14-4,310	20-167	1,300 (C4UL)	2,330	3 (2 x FM, 1 x DP)
Selenium	<1-3	<1-<3	<1-<3	na	<3	1,800	12,000	none
Copper	130-851	2-787	38-3,100	21-1,199	22-74	44,000	68,000	none
Zinc	179-4,700	38-5,803	64-660	93-8,075	27-333	170,000	730,000	none
Free Cyanide	<1	<1	<1	na	<1	none	none	-
Total Cyanide	<1-1	<1	<1	<1-22	<1	none	none	none
Thiocyanate	<1	<1	<1	na	<1	none	none	-
Total Phenols	<0.01-<1	<0.01-<0.05	<0.01-<1	<1-1.2	<0.01-0.21	3,200	3,200	none
Mineral Oil	54-207	<10-437	<10-24	na	<1-561 (EPH)	none	none	none
Toluene Extractable Matter	1,790 mg/kg - 7.50%	na	na	0.02-1.096 % w/w	n/a	none	none	-
Naphthalene (μg/kg)	1.48-4.601	<0.01-25.374	<0.01-0.798	na	0.207-1.592	3,000	1,100	none
Benzo(a)pyrene (μg/kg)	0.103-0.137	<0.012-1.635	<0.012-0.508	na	0.029-1.819	13	36	none
Asbestos	Chrysotile	nfd	nfd	na	na	nfd	nfd	none

Notes:

S4UL POS2: Safety 4 Use levels, Public Open Space 2 published by LQM/CIEH, 'Public open space park' scenario, published 2015. Copyright Land Quality Management Ltd reproduced with permission publication number S4UL3102. All rights reserved

S4UL Commercial / POS1: Safety 4 Use levels, Commercial published by LQM/CIEH, 'Commercial' scenario, published 2015. Copyright Land Quality Management Ltd reproduced with permission publication number S4UL3102. All rights reserved

Central Heritage Area

4.6.1. A number of soil samples were collected from the eastern edge of the Blast Pit area, generally at relatively shallow depths.

4.6.2. The fills were generally alkaline with toxic metals such as arsenic, mercury, chromium, and cadmium being either undetected or only present in concentrations below the S4ULs in 1995 and 2005. Nickel was the only metal to exceed its S4UL was nickel (800 mg/kg), in one sample of ash taken in 1995, at a concentration of 2,000 mg/kg. However, by 2005, the concentrations reduced to a range of 30-44 mg/kg, well below the S4UL.

4.6.3. Naphthalene, BaP, and Mineral oils were not detected in exceedance of their guideline values.

Duck Pond Area

4.6.4. Elevated levels of nickel and lead were detected in a few samples in exceedance of the S4ULs. The NEC analysis did not include chromium, but it was anticipated that elevated chromium levels were present within the slag material, and to a lesser extent ash material, across the area. Based on results for similar ground conditions elsewhere on the site chromium (VI) is not anticipated to be present at elevated concentrations, chromium being predominantly present as Cr (III).

4.6.5. The organic analysis was undertaken for phenols and TEM. Phenols were either undetected or only present at low concentrations to a maximum of 1.2 mg/kg. There are no guideline values for TEM, however all of the results apart from one were below 0.5% TEM and are not considered indicative of significant hydrocarbon contamination. One sample contained a TEM concentration of 1.096%. Thin layer chromatography identified this to be due to heavy engineering oil. This was a sample of slag that also contained the highest concentration of phenols, lead, total cyanide, and cadmium detected across the samples. The NEC analysis did not include PAHs; however, these are likely to be moderately elevated due to the presence of ash, coal and railway ballast.

Access Road

4.6.6. All metals / metalloids were below their respective S4ULs.

4.7. Aggressive Conditions for Building materials

Table 4.7.1: Summary of 1991 - 2005 Soil Analysis

Determinant	Central Heritage Area		Blast Pit Area	Duck Pond Area	Haul Road	Screening Soil Standard adopted and concentration	Exceedances
	Fill Material	Surface Residues					
	(mg/kg or indicated)						
No. of samples	6	12	8	20	5		
pH	7.78-12.2	2.33-9.45	6.8-12.1	7.4-10.9	7.53-8.55	<5; >9 UU	11 (4 x sands, 1 x BP, 6 x DP)
Total Sulphate	670-6,500	499-84,610	1,562-2,088	155-8,465	455-1,313	7,500 UU	4 (3 x sands, 1 x DP)
Acid Soluble Sulphide	4.2-837	<50		<1-392	50-165	250 UKWIR	1 (1 x DP)
Total Sulphur (%)	0.1-0.16	<0.01-2.84		na	0.04-0.12	none	-
Total 16 PAH (µg/kg)	4,254-10.391	<25-69,136	<25-8,063	na	1,052-36,077	200,000 United Utilities Action / 1,000,000 TPHCWG	none / none

4.7.1. Most of the samples were neutral to alkaline, with 10 samples exceeding the United Utilities' upper threshold limit for pH. However, these samples were taken in 1991 or 1995, and by 2005 most had receded to more neutral levels around 7 or 8 pH. One sample was reported to have a high acidity of 2.33 pH. This was a sample of sand taken from the foundry building in 2005. Two other samples taken in the foundry building had alkalinities exceeding the upper threshold limit; 9.14 pH (sand) and 9.45 pH (off-white powder). The value is used to assess the potential for damage to ductile iron pipes however the low pH of the ground in places also indicates the potential for aggressive ground conditions with respect to concrete.

4.7.2. There was one exceedance reported for acid soluble sulphide. A sample taken from the duck pond area in 1991 was reported to contain 8,465 mg/kg, exceeding the 7,500 United Utilities guideline value and potentially indicating that high sulphate conditions could exist in the future if oxidation occurs.

4.7.3. Since the materials on the site potentially contain pyritic material in colliery spoil the oxidisable sulphide content of the overburden fill and formation level was calculated in accordance with the methodology outlined in BRE SD1. The 0.3% threshold for total oxidisable sulphide was marginally exceeded in 1 out of 5 samples. On this basis pyrite is considered unlikely to be present in significant amounts.

4.7.4. Four samples contained total sulphate in exceedance of the UU screening threshold of 7,500

mg/kg, however, only the sample from the blast pit area was subject to additional analysis for water soluble sulphate. The sample contained water soluble sulphate in excess of the screening 1.2 g/l guideline limit provided in the BRE SD1 guidance recommending the use of sulphate resistant concrete for building development,

4.7.5. Based on these results, and the known history of the site, if new concrete structures are planned then a specific, more detailed assessment of local conditions will be required.

4.8. Surface Water

4.8.1. The area of the main site potentially falls into the catchment of two tributary systems: to the north is the Afon Cegidog (~1.3 km from the Heritage Module) that joins the Afon Alun at Cefn y Bedd and to the south is the Afon Gwenfro (~1.5km from the Heritage Module) that joins the Afon Clywedog in Wrexham. The Gwenfro is fed by the Lodge Stream, which runs down the valley along the eastern boundary of the main site. The stream forms the closest surface watercourse to the Heritage Area, lying about 700m to the east.

4.8.2. The drainage of the Heritage Area is complex due to the long history of development with both constructed drainage systems and former mine workings being present. Flows originate form the catchment of the Blast Pit and Duck pond areas which are fed by various relict drains and seeps form the upper parts of these in the south of the site, and potentially from higher ground above Blast and Brake roads, and the Wonder Bank. The former track bed crossing the lower parts of these sites appears to form the main drainage route and is prone to flooding under very wet conditions.

4.8.3. A series of ponds are located within the Blast Pit area which provide a Great Crested Newt Habitat. These were fed by a drain located at the base of the Supply Well building but the more general surface water flows running down through the Heritage Area parallel with Blast Road are also observed to feed these features.

4.8.4. There are two known drainage systems within the Central Heritage Area referred to as the Foundry Adit and Furnace Culvert.

4.8.5. The Furnace Culvert is located adjacent to the former blast furnaces. The water flows eastwards into the culvert from the direction of Blast Road and is thought to accept the combined drainage from the Blast Pit and Duck Pond areas, and possibly the NWDM. The flow from the Furnace Culvert is believed to pass below the western part of the car park to combine with the No 1 Gate Drain (flowing to the east of the Heritage Area) and Foundry Adit water, ultimately flowing to the Lodge Stream via the former road tunnel / Armco Tunnel drain.

4.8.6. The Foundry Adit drains acidic mine water and emerges within the Foundry. The flow is irregular but increases over winter and during wet periods. The water issuing from this adit

flows through a concrete lined channel located in the eastern area of the Heritage Area and then into a drain passing along the former road tunnel and Armco Tunnel to the Lodge Stream. Monitoring of the Foundry Adit during the reclamation works indicated that the discharge is typical of acidic mine drainage. The open-air concrete-lined channel was filled with crushed concrete to provide a temporary treatment method to raise the pH levels of the water, allow oxygenation and the precipitation of hydrated iron oxide (ochre) to minimize potential impacts on the Lodge Stream. Long term treatment options were reviewed as part of the long-term development of the Heritage Area.

Surface Water Quality

4.8.7. Three samples were collected in March 2005 of the surface water within the Blast Pit area, one of which was from a drain at the base of the Supply Well building which forms the primary source of water for the newt ponds and one each from ponds 4 and 5. A further 22 samples were taken from the Reed Bed Outlet located on the eastern slopes to analyse the quality of the drainage from the Armco tunnel and the slopes. The analytical results have been compared against the EQS values previously provided to SGP by the EAW as being relevant to the nearby receiving watercourses (Afon Gwenfro and Afon Cegidog) (these have not changed since 2009). These relate to iron, lead, chromium, nickel, cadmium, mercury, copper and zinc. For other determinants, reference has been made to national EQS values or in the absence of an EQS, the UK “Drinking Water Standards”.

4.8.8. The three samples were slightly alkaline and contained exceedances of the relevant EQS values for iron and nickel. Only 2 samples did not exceed the iron EQS value of 1,000 ug/l. These were taken in November 2005 and October 2006. The rest of the samples exceeded the EQS in a range of 1,254 ug/l to 32,480 ug/l. The samples from the drain outlet contained manganese and magnesium in exceedance of the UK Drinking Water Standards. These standards are highly stringent as they are designed to be protective of public drinking water supplies and do not indicate any contamination of concern. The samples taken from the reed bed outlet reported 9 chromium exceedances (maximum 113 ug/l), however, monitoring of the Lodge Stream reported no exceedances.

4.8.9. A sample was collected of the Furnace Culvert in February 2005. The water was slightly alkaline with no determinants being present in excess of the relevant EQSs and no evidence of hydrocarbons, PAHs, VOCs or SVOCs. The results for the key determinants for the water samples from the newt ponds, Furnace Culvert, receiving ponds, and filter beds located on the eastern slopes are summarised below in Table 2.

Table 2: Summary of Analysis for Key Determinands for Surface Waters Draining to, located in, and exiting from, the Heritage Module

Determinant	Range (µg/l unless stated)				Standard Adopted	Exceedances
	Newt Ponds (3)	Furnace Culvert (1)	Pond Receiving WB Drainage (1)	Reed Beds Outlet (22)		
pH	7.93-8.37	8.19	8.51	8-8.83	6-9 EQS	none
cadmium	<0.4	<0.4	0.9	<0.4-1.5	5 EQS	none
chromium	2-5	4	10	24-113	50 EQS	9 (9 x RBO)
copper	<1-2	4	23	<1-96	112 EQS	none
lead	<1	<1	2	<1-15	20 EQS	none
mercury	<0.05	<0.05	<0.05	<0.05-0.06	1 EQS	none
nickel	<1-7	2	39	<1-11	200 EQS	none
zinc	9-35	34	21	3-181	500 EQS	none
mineral oil	<10	<10	<10	-	10 UK DWS	none
total PAH 16	<0.01	<0.01	<0.01	<0.01	none	none
naphthalene	<0.01	<0.01	<0.01	<0.01	10 EQS	none
benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	0.01 EQS	none

4.8.10. In the Ffrith valley, to the east via old mineworkings to mine discharges to the Afon Alun near Cefn-y-Bedd or to the south via the Tan-y-Fron Adit and discharging to the Afon Gwenfro. However, routine testing undertaken between 2003 and 2007 of a series of mine adits thought to possibly take drainage from the site did not identify any steelworks pollution.

Groundwater Quality

4.8.11. Groundwater within the main site and surrounding area was sampled and assessed prior to the on-set of reclamation activities (Summary Review of Baseline Water Quality Prior to Commencement of Works, October 2003, SGP, Ref: R175-R13). The groundwater from remaining boreholes across the site was subsequently sampled in 2004, 2005 and 2006. The groundwater underlying the main site was found to be of generally poor quality, both due to the natural poor quality of groundwater within Coal Measures and arising from the long industrial history of the site. The EAW agreed that the groundwater beneath and around the site is not

considered a sensitive receptor in its own right and is not likely to be used as a supply of potable water in the foreseeable future. The groundwater is considered primarily as a pathway to other sensitive receptors.

4.8.12. Specific groundwater monitoring comprised the sampling of boreholes HT1 (2003 and 2004), Supply Well (2003, 2004 and 2005) and HT2 to the immediate south (2003 and 2004). Seepages from two of the excavated trial pits (HA7 in the Blast Furnace area and BM1 in the Duck Pond area) have also been analysed. All the determinants for which EQSs have been established were below the relevant EQS. EPH was detected in the Supply Well (155-617 μg/l) and to a lesser extent HT1 (23-83 μg/l).

4.8.13. A comprehensive monitoring programme of the external mine adits in the surrounding from October 2003 to December 2006 showed little or no evidence of steelworks-derived leachate, other than an isolated occurrence of elevated chromium concentrations at several near and distant mine drains in Autumn 2004. Levels subsequently returned to previous concentrations.

Foundry Adit

4.8.14. The Foundry Adit was sampled on 22 occasions between 2003-2006. The adit was confirmed as carrying acid mine drainage (~pH3 with high dissolved iron and nickel content at levels in excess of the EQS), particularly at times of low flow, with no evidence of steelworks leachate. No determinands such as lead, cadmium, copper, zinc etc are present in the adit drainage in excess of the relevant EQSs and there are no indications that the site reclamation works had any appreciable impact on the Foundry Adit quality.

4.8.15. Since May 2005 the adit water has been directed to a drainage channel lined with crushed concrete created as a temporary treatment system to raise the pH and oxygen content prior to drainage to the Armco Tunnel and thence the Lodge Stream. Monitoring of the inflow and outflow in mid-2005 demonstrated a slight raising of the water pH and reduction of dissolved iron and nickel between the inlet and outlet.

4.8.16. From 2005-2009, samples could only be taken from the Lodge Stream due to the sampling point at the drainage tunnel being inaccessible. Dissolved iron and nickel in the stream remained below the relevant EQS and the pH above the EQS of 6 indicating the acid drainage from the Foundry Adit has not impacted the stream. Isolated exceedances of the discharge consent of 5 mg/l total iron have been reported in the Lodge Stream, although with only one exceedance between January 2007 and April 2008. A site visit on the 7th August 2009 confirmed the on-going absence of ochre deposition at the Armco Tunnel outlet to the Lodge Stream.

4.9. Recent Monitoring

4.10. SGP are instructed by BH to reinstatement monitoring of both the Furnace Culvert and the discharge from the Heritage Area to the drains along Phoenix Way to assess whether there has been any change in the potential for pollution of surface waters from the site since the cessation of the previous monitoring programmes and inform the design of any attenuation required to manage long-term risks of pollution.

4.11. Samples were taken from the Foundry Adit and a ditch where water flows from the foundry adit drain and enters the surface water drains along Phoenix Way. A direct sample from the drain could not be taken due to minimal flow. The only exceedance of the EQS in the samples was from the foundry adit. It had a low pH of 3.66. However, the sample taken from drain had a more neutral pH of 6.29. This indicates that the low pH was being attenuated in between the Foundry adit discharge and entry to the surrounding surface water drainage network.

4.12. The monitoring was carried out during a period of very low flow; flow in the drain was estimated at < 1 l.s.

4.13. Ground Gas

4.13.1. Gas concentrations of methane, carbon dioxide and oxygen were recorded on one occasion in 1995 within the completed boreholes across the steelworks site, two of which (BFB1 and BFB2) were within the Heritage Area. Methane and carbon dioxide were not detected in either borehole with no evidence of oxygen depletion.

4.13.2. The boreholes elsewhere on the main site were located in a number of areas deemed to be potentially capable of generating gases including the Wonder Bank, Works Tip, Upper Blast Furnace area and main steelworks area. Significant concentrations of methane or carbon dioxide were not detected in the Billet Mill, Works Tip or Steel Works and it was considered there was little evidence of ground gas generation across the main part of the site.

4.13.3. Methane was only detected in one borehole across the site in 1995 (within the former coke ovens area) and at 0.1% was not considered significant.

4.13.4. Significant quantities of biodegradable materials that may give rise to significant levels of ground gas have not been identified in any of the boreholes or trial pits in the Heritage Area, although pockets of materials such as wood are present that could produce low volumes of gas.

4.13.5. The three groundwater monitoring wells downgradient of the NWDM (CP1-CP3) were monitored for ground gas on ten occasions alongside probe hole monitoring of the development plateau itself. This provides further background information on the ground gas status of the general area. Methane was detected in one borehole on only three occasions at 0.1 – 0.7%. Carbon dioxide was detected in two of the boreholes on all monitoring occasions in the ranges

1.9-3.7% and 1.1-2.2% respectively along with corresponding depleted oxygen. Traces of VOCs were detected in the boreholes on several occasions up to a maximum of 5.8ppm.

4.13.6. In general, the fills on the site are considered to have a low to moderate potential to generate elevated concentrations of ground gas and high relative pressures and sub-surface flows / surface emissions are not anticipated. Risks locally to shallow mineworkings and mine entrances may be substantially higher and less predictable as displacement of mine gas accumulating in voids can be substantially affected by groundwater and atmospheric pressure conditions.

5. Planned Future Use: Receptors and Exposure

5.1. Current status and General Proposals

5.1.1. The site has remained largely undisturbed apart for some minor works to stabilise and preserve relict structures of architectural of cultural value since the completion of the wider Steelworks reclamation and remediation over a decade ago. Over the past several years, workers and volunteers for BH have accessed the land and used various areas for relatively various projects, such as open days/educational tours for the public, concerts and the provision of BH stores and offices.

5.1.2. The site is currently accessed for by a small number of part – time workers and volunteers, and more infrequently by members of the public attending events. Most time by both groups is spent within offices in the site portacabins and one of the existing buildings, (the machine shop) and the lower central heritage area, which is provided with a mix of hard surfacing and placed stone aggregate.

5.1.3. Current frequencies and durations of exposure are therefore limited and not fully comparable with fully publicly accessible areas with external spaces, such as parks or gardens. The most heavily utilised buildings and spaces (the lower central Heritage Area) and also benefits from the presence of a large proportion of surface cover by slabs or placed aggregate, isolating users form exposure to shallow soils and fills. However, in the absence of a site-specific assessment, the adoption of the generic assessment criteria for parks is considered suitably conservative and protective.

5.1.4. BH plan to acquire all of the land forming the Central Heritage Area, Blast Pit Area and Duck Pond Areas and develop these largely derelict spaces into an asset for the local community and wider society. The plans entail transforming the Heritage Area into a mixed-use visitor attraction, social & amenity space, retail and commercial units and community hub.

5.1.5. This change of use is intended to bring the site back into use for the benefit of the local and wider communities, therefore by definition increased access to various parts of the site can be anticipated. In order to allow assessment of contingent risks from ground contamination associated with the various changes of use.

5.1.6. It is also relevant that a temporary significant in crease in exposure to potentially contaminate soils would be anticipated during any construction or maintenance works that involve excavations, groundworks or the relocation of materials. It is understood that nearly all the plans involve works to existing structures and the placement of new surfacing, however for certain activities, specifically the construction of new drainage, services and utilities, and for certain restoration works (laying new track bed for railways) some disturbance of the ground

and temporarily elevated exposure to soils & fills may be anticipated.

5.2. Central Heritage Area

5.2.1. It I intended that the existing machine shop will be repurposed into a visitor centre and that the rear areas of more degraded buildings will be stabilised and open to visitors as part of a formal exhibit, although not restored. These areas will be accessed through the central open parts of the Lower Central Heritage area and presumably served by a car part formation Phoenix Way. It is believed that a footpath and disabled access will be established linking the Lower, middle and upper parts of the Central Heritage area, so access to most external areas will be attained.

5.2.2. It is therefore likely that the number of visitors to the site will increase substantially once the redevelopment is complete, although the exposure duration and frequencies are not likely to substantially change. A small cohort of repeat visitors may be established but exposure frequencies and durations greater than the exposure frequency of 85 days a year or 2 hours per day used to establish the S4UL POS2 (Parks) are unlikely to be exceeded.

5.2.3. A small number of full or part time workers will be required to staff the new facilities. These individuals would be anticipated to have a much-increased frequency and duration of time spent on the site (assumed to be normal full-time working hours considered under the S4UL commercial land use scenario), however conversely would be less sensitive adults than the children and infants considered under other land use scenarios.

5.3. Blast Pit Area

5.3.1. The upper Blast Pit area is largely derelict, and it is understood that apart from stabilising the remaining mine buildings, that this area is not going to be brought into public use apart from the establishment of a number of paths through the largely overgrown steep banks. On the northern boundary, along the haul road a small orchard has been established and a number of beehives are present as small community projects which may be expanded over time.

5.3.2. It is understood that it is intended to refurbish / reconstruct the track bed and railway tracks present in the Lower Blast Pit area and possibly permanent establish a number of items of vintage rolling stock for the purposes of office space, for these facilities similar exposure frequencies and durations as experienced by the workers in the visitor centre and museum would be anticipated.

5.4. Duck Pond

5.5. The upper Duck Pond has been partially covered by a layer of clean stone aggregate and is being used for storage of a number of containers, and it is understood that under the current scheme, only an extension of this activity is planned. It is therefore considered that exposure in this area will be highly sporadic, and of low intensity and duration.

5.6. The Lower Duck pond area is understood to currently form the upper part of the same ecological corridor as the lower part of the Blast Pit area and similar, infrequent, transient and low intensity exposure of both visitors and workers is anticipated in this area.

6. Conceptual Site Model

6.1. Conceptual Site Model

6.1.1. The conceptual model for the site describes the potential contamination sources, pathways and receptors. Development of a conceptual model is required to evaluate potential risk to receptors. The plausible sources, pathways and receptors are outlined below.

6.2. Sources of Contamination

6.2.1. The principal source of contamination across the main site was metalliferous slags and other wastes used as general fills and hardcore or construction materials. Slag was tipped in large quantities across the site near the works to form space for subsequent expansion. The main areas of tipping were to the east and south of the Blast Furnace area although some slags are likely to have been deposited within the Heritage Module itself.

6.2.2. Typical wastes associated with the operations of the iron and steelworks within the Heritage Module include boiler ash, refractory bricks from flue and furnace linings, flue dusts and soot from ducts, air filters and chimneys, scale and sludges from cleaning baths and water treatment plants, acid alkalis and waste oils. Demolition rubble is present locally from the demolition of buildings in the area over time, particularly in the lower furnace floor area.

6.2.3. The available soil results and qualitative review of the site history indicates there is likely to be made ground comprising various moderately contaminated materials over much of the area.

6.2.4. Principal wastes within the Blast Pit area are likely to include colliery spoil with some steelworks waste.

6.2.5. No significant sources of contamination within the Duck Pond area have been identified other than the probable fill material, including slags and ash.

6.3. Potential Targets

6.3.1. The proposed use of the site is currently anticipated to be for continued commercial use as an educational experience, preserving the history of the site. In the absence of site-specific information on the land use in terms of receptor exposure durations , frequencies and activities, this can be considered a relatively low sensitivity Public Open Space and / or Commercial development scenario with respect to human health. The principle receptors to any potential contamination would therefore be future site employees, construction and maintenance workers, and future site visitors, in particular children.

6.3.2. The adjacent area remains predominantly residential or undeveloped with an occupied business premises immediately adjacent to the site's northern boundary. The immediate east remains undeveloped land and to the west is the Wonder Bank.

6.3.3. The Minor Aquifer and the unproductive superficial deposit beneath the site are unlikely to be sensitive receptors to pollution, however discharge form the Foundry Adit on the site continues to enter the surrounding network of surface water drains and is believed to ultimately discharge to the nearby Lodge Stream surface watercourse.

6.4. Human Health Risk Assessment

6.4.1. The potential for significant contamination to be present that may pose an acute risk to workers is considered moderate-high. The site surface is partially covered by concrete hardstanding, precluding the potential for direct exposure to soil contaminants in those areas. The rest of the site is vegetated, with old rail beds, tracks, structures, and ponds.

6.4.2. The workers who would be anticipated to be more at risk from exposure would be maintenance and construction workers during excavations when exposed soils could feasibly be ingested or inhaled. However, the duration and frequency of such activities during the normal operation of the site is likely to be limited and normal occupational hygiene measures and health and safety controls would be adequate to manage risks.

6.4.3. Therefore, while the historical analysis testing available indicates occasional exceedances of generic and highly protective Commercial or Public Open space land use acceptance for nickel and lead, this is recognised to be based on a conservative set of assumptions regarding the future use of the site.

6.4.4. The proven depth of made ground on the site is relatively shallow and, based on the age of the deposit and the descriptions provided in the available site investigation, not likely to contain any appreciable quantity of degradable organic matter, so risks from hazardous ground gas generation within the site are considered low. The mineshafts on site were closed and infilled in 1914. Due to the age of the shafts, they are unlikely to cause ground gas risks. Other sources in the surrounding area range from a nearby mineshaft, to areas of landfill, however similarly the age of the deposits and/or the distance between the source and receptor infer a low-level of risk.

6.5. Controlled Waters Risk Assessment

6.5.1. The site is in an area of low environmental sensitivity as far as groundwater is concerned with historical impacts from Coal Mining restricting the usefulness of the local groundwater resource. While the historic fill materials present may contain some elevated levels of contaminants and the potential for infiltration and leaching does exist, in the wider context of the steelworks and low sensitivity of local groundwater, risks to groundwater are not considered significant.

6.5.2. Drainage from a historical mine adit emerges within the site and discharges to the surrounding surface water drainage network, and it is assumed, Lodge Stream. Previous monitoring indicated that significant pollution of this watercourse was not occurring while the flow was diverted into an attenuation channel containing crushed concrete intended to balance the pH and promote precipitation of ochre and c- precipitation of more polluting heavy metals. Based on the single recent round of monitoring carried out under low-flow conditions, this appears to remain the case, however a degree of uncertainty as to the impacts under a range of discharge rates remains.

6.6. Conceptual Site Model

6.6.1. A Conceptual Site Model (CSM) was derived for the site using the information described above, describing the potential contamination sources, pathways and receptors. The CSM is summarised below in Table 5.1:

Preliminary Conceptual Site Model

Receptor	Source / Contaminant	Pathway / Exposure	Pollutant Linkage (in absence of mitigation)	Further Works
1. humans – site workers including construction workers / future maintenance workers	Metals / metalloids / asbestos / PAHs / heavy hydrocarbons	Dermal contact / ingestion / inhalation – short term exposure	**Unlikely** – Made ground is expected across the site, contaminants likely to pose acute risks are not expected and exposure is likely to be limited, however precautions to maintain exposure as low as reasonably practicable can be adopted	Normal occupational hygiene and health and safety provision should adequately manage risks; if excavations are intended a watching brief for more significantly contaminated materials is prudent.
2. humans – adjacent site users and neighbouring residents	Metals / metalloids / asbestos / PAHs / heavy hydrocarbons	Windblown dust / ingestion / inhalation	**Unlikely** – Made ground is expected across the site and sufficient mobilisation to cause unacceptable exposure is likely to be limited under the current site-use	No actions unless significant earthworks / disturbance is proposed: site is hard surfaced or heavily vegetated reducing potential for erosion and mobilisation through dust; heavily used running surfaces and tracks are metaled, armoured or protected by clean aggregate and this should be continued / maintained to prevent runoff and dust generation.

Receptor	Source / Contaminant	Pathway / Exposure	Pollutant Linkage (in absence of mitigation)	Further Works
3. humans – site workers & visitors	Metals / metalloids / asbestos / PAHs / hydrocarbons	Dermal contact / ingestion / inhalation – long term exposure	**Unlikely** – Made ground is expected at the site, and highly protective thresholds for industrial / commercial use are exceeded for some heavy metals however precautions to maintain exposure as low as reasonably practicable can be adopted	Site soils / fills are exposed in places, however in general exposure duration and frequencies are likely to be considerably less than those assumed in the screening criteria adopted and the lack of widespread exceedances indicates low risk. However, for high frequency use areas, particularly where children will be present, surfacing of heavily used running surfaces and tracks are metaled, armoured or protected by clean aggregate and this should be continued / maintained. If play areas or picnic areas are proposed consideration should be given to providing a clean surface and maintaining this.
	Ground gas (methane, carbon dioxide)	Accumulation within voids, confined spaces and service runs to toxic concentrations	**Unlikely** – Significant thickness of made ground have been proven on the site but with limited potential for degradable materials reported. Ground gas sources exist in the surrounding area and on the site, in particular the historical mine entrances and shallow workings, however accumulation to hazardous concentrations is not anticipated. The site is located within an area where maximum radon potential is 5-10%.	No Actions unless new habituated structures with limited ventilation are planned in which case more detailed assessment is required, in particular if structures with limited ventilation are planned in the vicinity of historical mine entrances.
	Radon gas from natural ground			

Receptor	Source / Contaminant	Pathway / Exposure	Pollutant Linkage (in absence of mitigation)	Further Works
4. property / services New buildings, listed buildings, scheduled ancient monuments	Ground gas (methane)	Accumulation within voids, confined spaces and service runs to flammable concentrations	**Unlikely** – Limited thickness of made ground have been proven on the site with no degradable materials reported. Ground gas sources exist in the surrounding area, however accumulation to flammable or explosive concentrations is not anticipated	No Actions unless new habituated structures with limited ventilation are planned in which case more detailed assessment is required, in particular if structures with limited ventilation are planned in the vicinity of historical mine entrances.
	pH, sulphate, organic chemicals	Chemical attack of buried concrete and plastic materials	Unlikely – Material with high sulphate concentrations are anticipated to be present on site. Permeation of water supply pipes at rates likely to cause toxification are not anticipated, however the appropriate risk assessment for the utility provider for new connections of potable water should be completed	No Actions unless new buried concrete structures and new water supply pipes are planned, then investigation of local conditions and completion of the appropriate risk assessment is deemed prudent
4. vegetation / landscaping	leachable metals / metalloids may be present within made ground / natural soils	plant uptake	**Unlikely** – A lot of the site is uncovered, vegetated land with no evidence of blight or dieback, some sensitive species may be impacted by elevated metals (Copper & zinc).	No Actions unless new planting of sensitive species is proposed in which case further assessment may be prudent, or the provision of clean soil as a growing medium.
5. ecosystems / protected species & habitats	Metals / metalloids / asbestos / PAHs / heavy hydrocarbons	Bioaccumulation or acute effects through the release of pollutants to surface watercourses	**Unlikely** – The newt colony on the site is believed to be long-established under the ambient conditions	No Actions unless disturbance in the vicinity of the habitat or upstream are considered in which case specialist advice should be sought as part of a wide ecological assessment by specialists
6. surface waters – Site drains discharging to local surface water drains and Lodge Stream	Leachable metals / metalloids / asbestos / PAHs / heavy hydrocarbons	migration via shallow groundwater / surface water run-off.	**Possible** – Currently the discharge from the Foundry Adit appears to be sufficiently attenuated by the passage through the site drainage system to not pose any pollution risk, however confirmation that this remains the case under high flow conditions is required	Additional surface water sampling round under high flow conditions & design of any new drainage system to incorporate sufficient attenuation to preclude polluting discharge to the local surface water drains & Lodge Stream

Receptor	Source / Contaminant	Pathway / Exposure	Pollutant Linkage (in absence of mitigation)	Further Works
7. groundwater – Unproductive aquifer within drift deposits and minor aquifer within bedrock.	Leachable metals / metalloids / asbestos / PAHs / hydrocarbons (fuels oils solvents)	migration via saturated zone	**Unlikely** – Any made ground present on site may contain elevated concentrations contaminants, but these are likely to be largely immobile in the sub-surface and leaching limited in the context of the wider surrounding area, receptors are recognised as low sensitivity.	No Actions

7. Conclusions & Recommendations

7.1. Conclusions

7.1.1. In general, the contamination status of the Heritage Area is not considered to pose a significant constraint to the planned future educational, tourism, commercial and social enterprise uses.

7.1.2. Thresholds for human health protection commercial and Public Open Space (POS Parks) uses are exceeded for heavy metals in a minority of the sample population available for review, however these are derived using much higher exposure frequencies and durations than would be anticipated under the planned land uses. Despite this some basic, practical mitigation measures can be adopted to further reduce exposure under some of the anticipated development / construction scenarios that will need to take place to facilitate the planned uses of the site.

7.1.3. These will mostly be limited to simple barrier measures to reduce exposure of soil and fill materials at the surface and are deemed a proportionate response to any remaining uncertainty, particularly in areas where increased exposure of soils along paths and running areas, or the introduction of visitors, particularly young children is to be encouraged, for example play or picnic areas.

7.1.4. In addition, where any works are planned involving excavations and new structures there is a small but not necessarily negligible possibility that uncharacterised wastes including hazardous substances may be exposed. If new development requiring excavations, earthworks of changes to the exposure pathways considered in this review are planned then some further assessment of risks, limited investigations and supplementary risk assessments can be carried out to address any remaining uncertainty.

7.1.5. Pollution risks appear to be limited; risks to groundwater are not considered to be significant and there is a historical precedent that this has been agreed with the regulators, such risks are unlikely to be increase under the proposals. Currently the surface water discharge from the site appears unpolluted but assessment of this under a range of flow conditions is needed and an assessment of the best means of maintaining safe, unpolluting discharge to surface waters must be considered, especially where changes to the drainage of the site are considered.

7.2. Recommendations

7.2.1. For any activities involving excavations, the operatives and site supervisors should maintain a watching brief for any suspicious materials, including asbestos containing materials (ACM) wastes, oils, unusual odours, colours or staining. If suspect materials are encountered works should cease in the impacted area and an assessment made by a competent person. Arisings should be treated as contaminated, adequately characterised, and stored and disposed of appropriately.

7.2.2. Any new utility trenches should be backfilled with clean materials; if new potable water supply pipes are to be laid, then the utility provider is likely to require a risk assessment in case chemical resistant pipe materials are required.

7.2.3. If new concrete structures are present, further testing for pH and sulphate /sulphide / total sulphur should be carried out as part of any geotechnical assessment for assessing ground stability, bearing capacity etc.

7.2.4. If new habituated buildings are proposed, or alterations to existing buildings bring them back into use an assessment of the level of ventilation should be carried out. Risks from radon or other hazardous ground gasses should be assessed, particularly where enclosed and poorly ventilated spaces are to be introduced in areas around mine entrances.

7.2.5. Existing and new paths, tracks, roads and running areas should be appropriately surfaced and maintained to prevent erosion and release of windblown dust, runoff and tracking back of soils into vehicles and indoor areas. This could include metalled roadways in high traffic areas or the application of a layer off compacted aggregate, provided this is maintained. The use of a basal geotextile as a marker layer and regular inspections can allow early indication that erosion and exposure of the underlying, potentially contaminated materials is possible so that reinstatement can be carried out.

7.2.6. Areas where informal access is encouraged, in particular external unsecured areas of landscaping that can be used for amenity, food consumption or extended periods of time by children and infants (play areas, picnic areas, and grassed areas) should be treated by the application of a layer of clean soil to provide a growing medium for turf or other clean uncontaminated materials that can be maintained to isolate visitors from site soil and fill materials. The use of a basal geotextile as a marker layer and regular inspections can allow early indication that erosion and exposure of the underlying, potentially contaminated materials is possible so that reinstatement can be carried out.

7.2.7. Works to improve the site drainage will require careful planning to ensure that contaminated water is not diverted to surface watercourses. With respect to the existing acid mine discharge from the foundry adit, some additional monitoring is required to demonstrate that the lack of downstream impacts continues under different flow conditions and samples from the same locations should be collected during a period of high flow rates. If changes to the site drainage are considered then a means of attenuating the low pH, metalliferous waste reform the Foundry Adit must be maintained but (subject to the results of further monitoring) this does not currently appear to present any pollution risk.

7.3. Limitations

Stratigraphy

7.3.1. The evidence of stratigraphy is taken from information partially provided by other parties and from various investigations carried out for differing purposes and to contemporary standards. Whilst it is usually reasonable to infer that similar conditions may extend across the site; caution should be exercised.

Contamination

7.3.2. Data on soil, gas and water contamination is taken from information partially provided by other parties and from various investigations carried out for differing purposes and to contemporary standards.

Soil gas and groundwater

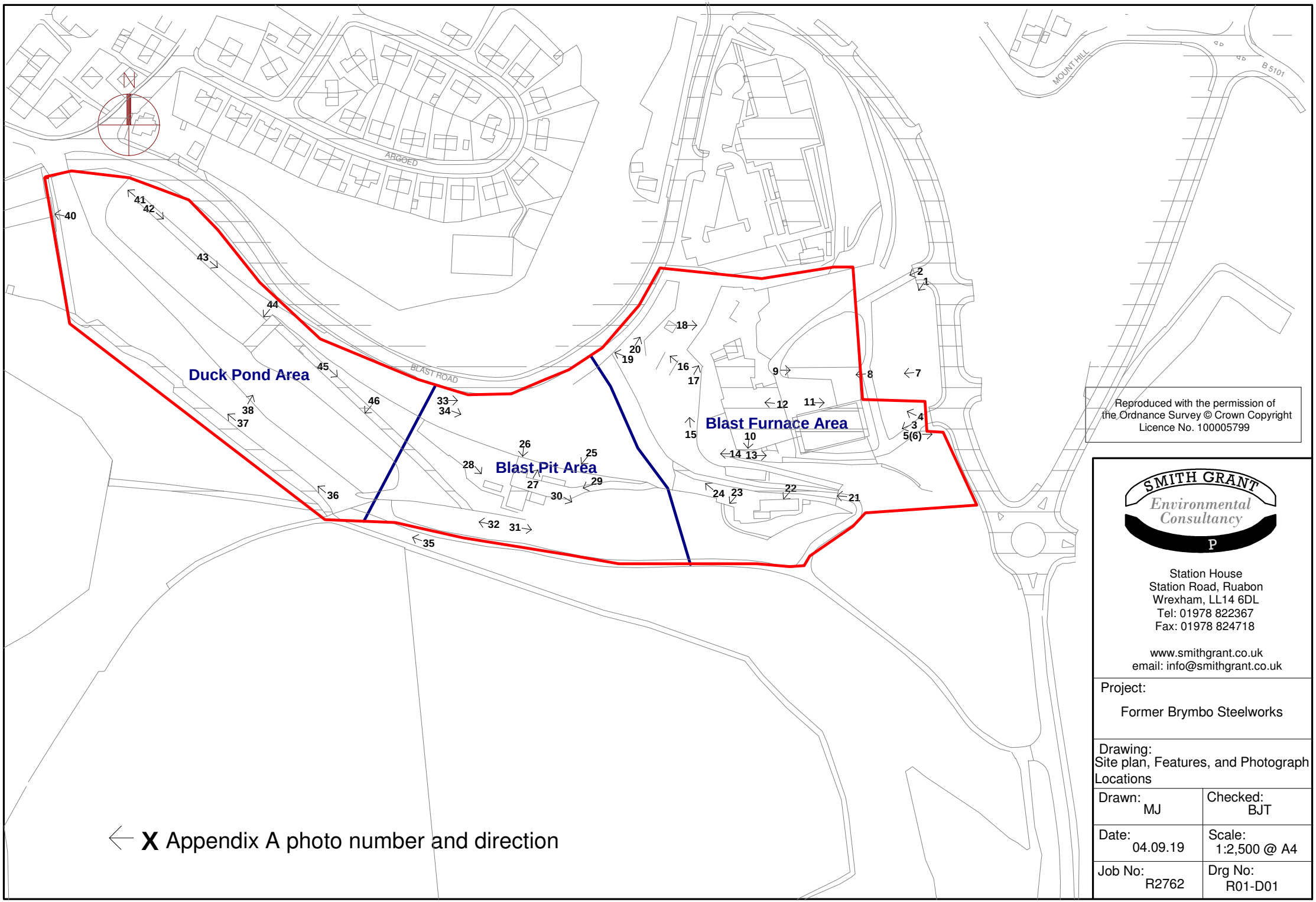
7.3.3. Any comments made on gas and/or groundwater conditions are based on third party information and observations during the site walkover. It should be noted that gas concentrations and pressures and groundwater levels and concentrations of substances may vary according to seasonal or weather-related effects, sometimes in an unpredictable fashion.

General

7.4. This report has been prepared by SGP for the sole and exclusive use of Brymbo Heritage Trust. Reasonable skill, care and diligence has been exercised within the budget available, and in accordance with the technical requirements of the brief. Notwithstanding the efforts made by the professional team in undertaking the assessment and preparing this report, it is possible that other ground conditions and contamination as yet undetected may exist. Reliance on the findings of this report must therefore be limited accordingly. Such reliance must be based on the whole report and not on extracts which may lead to incomplete or incorrect conclusions when taken out of context.

7.5. SGP reserves the right to alter any of the foregoing information in the event of new information being disclosed or provided and in the light of changes to legislation, guidelines and responses by the statutory and regulatory authorities.

DRAWINGS



← **X** Appendix A photo number and direction

Reproduced with the permission of the Ordnance Survey © Crown Copyright Licence No. 100005799

SMITH GRANT
Environmental Consultancy

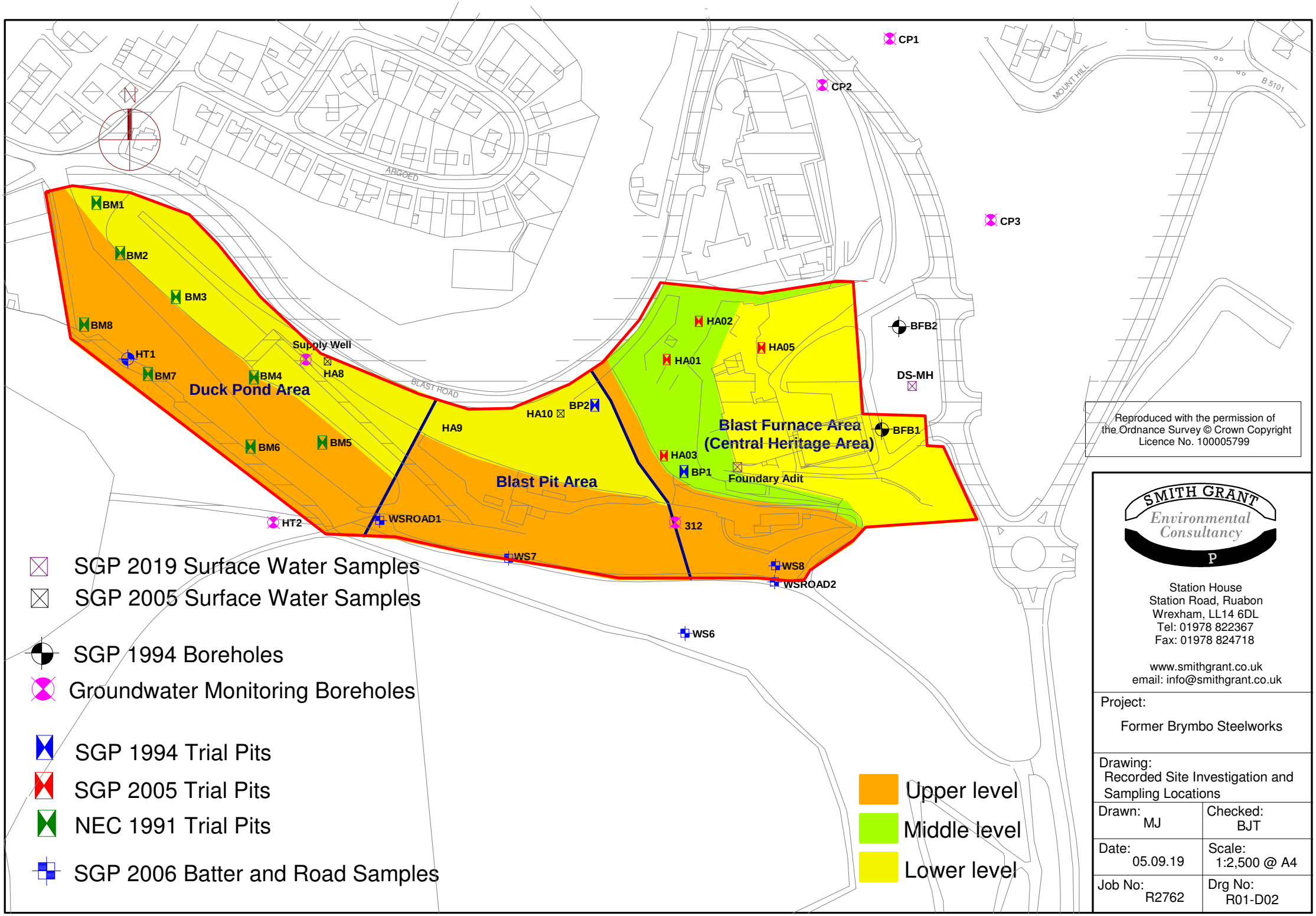
Station House
Station Road, Ruabon
Wrexham, LL14 6DL
Tel: 01978 822367
Fax: 01978 824718

www.smithgrant.co.uk
email: info@smithgrant.co.uk

Project:
Former Brymbo Steelworks

Drawing:
Site plan, Features, and Photograph Locations

Drawn: MJ	Checked: BJT
Date: 04.09.19	Scale: 1:2,500 @ A4
Job No: R2762	Drg No: R01-D01



Reproduced with the permission of the Ordnance Survey © Crown Copyright Licence No. 100005799

SMITH GRANT
Environmental Consultancy

Station House
Station Road, Ruabon
Wrexham, LL14 6DL
Tel: 01978 822367
Fax: 01978 824718

www.smithgrant.co.uk
email: info@smithgrant.co.uk

Project:
Former Brymbo Steelworks

Drawing:
Recorded Site Investigation and Sampling Locations

Drawn:	Checked:
MJ	BJT
Date: 05.09.19	Scale: 1:2,500 @ A4
Job No: R2762	Drg No: R01-D02

APPENDIX A

Photographic Record

1.



View SW from northern spine road access over Car Park with Central Heritage area beyond

2.



View W from northern spine road access over Car Park and entrancer gate with Central Heritage area beyond; retaining walls form northern boundary with adjacent Enterprise Centre

3.



View W from southern spine road access over Car Park with Central Heritage area beyond; Machine Shop frontage

4.



View NW from southern spine road access over Car Park with Central Heritage area beyond

5.



Manhole cover to Foundry Adit drain at site boundary

6.



Slight ocherous flow in Foundry Adit drain

7.



Open ditch containing Foundry Adit drain in Car Park area

8.



Covered drain containng Foundry Adit drain at soutehrn boundary to central heritage area

9.



Open ditch containing Foundry Adit drain in Central Heritage Area

10.



Foundry Adit discharge to Foundry Adit Drain

11.



View S over Central Heritage Area, lower level; Machine Shop

12.



View N over Central Heritage Area, lower level; Forge Area

13.



View E down access ramp between lower and middle Central Heritage areas past Forge and Machine Shop

14.



View W up access ramp between lower and middle Central Heritage areas past Forge

15.



View N over southern end of middle Central Heritage area plateau

16.



View N over northen end of middle Central Heritage area plateau

17.



View N over southern end of middle Central Heritage area plateau

18.



View E over southern end of lower Central Heritage area area

19.



View NW over upper Central Heritage area; Gate fronts Blast Road, Blast Pit to E.

20.



View NW over upper Central Heritage area towards Enterprise Centre

21.



View W up access track from top of Ramp between middle and upper Central Heritage area

22.



Agents house

23.



Ruined buildings near boundary between upper Central Heritage Area and Blast Pit Area

24.



Relict railway tracks near boundary between upper Central Heritage Area and Blast Pit Area

25.



Series of retaining walls separating former Blast Pit colliery buildings from lower Blast Pit Area

26.



Eastern Blast Pit shaft

27.



Western Blast Pit shaft

28.



Ruined Blast Pit colliery buildigns

29.



View E. up track to ruined Blast Pit colliery buildings

30.



View W back fown track towards upper Central Heritage area (track up to upper Blast Pit a rea southern boundary with haul road)

31.



View E along southern boundary Blast Pit area with Haul Road (past ruined colliery buildings)

32.



View E along southern boundary of upper Blast Pit area with Haul Road

33.



View E over lower Blast Pit area

34.



View SE over lower Blast Pit area

35.



View W up Haul Road towards upper Duck Pond Area access (past E. corner Wonder Bank)

36.



View NW from access track onto upper Duck Pond area (past NE. boundary Wonder Bank)

37.



View NW from over central upper Duck Pond area, new stone aggregate surfacing (past NE. boundary Wonder Bank)

38.



View N from over centralupper Duck Pond area concrete slabs past wooded bank down to lower Duck Pond area

39.



View NW from upper central upper Duck Pond area towards gate

40.



Gate at NW corner upper Duck Pond area fronting top Blast Road past wooded bank down to lower Duck Pond area

41.



View NW from lower Duck Pond area towards NW corner of site up relict trackbed

42.



View SE from lower Duck Pond area from corner of site down relict trackbed

43.  View NW from lower Duck Pond area from corner of site down relict trackbed past northern boundary with Blast Road (coal hopper at mid point along lower Duck Pond area)	44.  Coal Hopper
45.  View NW from lower Duck Pond area from corner of site down relict trackbed past northern boundary with Blast Road	46.  Newt pond at SE of lower Duck Pond area.

APPENDIX B

Surface Water Monitoring Results & Analysis

Element Materials Technology
Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

P: +44 (0) 1244 833780
F: +44 (0) 1244 833781
W: www.element.com

Smith Grant LLP
Station House
Station Road
Ruabon
Wrexham
LL14 6DL

Attention :	Ben Thomas
Date :	17th September, 2019
Your reference :	R2762
Our reference :	Test Report 19/14334 Batch 1
Location :	Brymbo Heritage
Date samples received :	5th September, 2019
Status :	Final report
Issue :	1

Two samples were received for analysis on 5th September, 2019 of which two were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:

Phil Sommerton BSc
Senior Project Manager

Please include all sections of this report if it is reproduced

Element Materials Technology

Client Name: Smith Grant LLP
Reference: R2762
Location: Brymbo Heritage
Contact: Ben Thomas
EMT Job No: 19/14334

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

EMT Sample No.	1-4	5-8									LOD/LOR	Units	Method No.
Sample ID	FOUNDRY ADIT	DS-MH											
Depth													
COC No / misc													
Containers	HN HCL Z P	HN HCL Z P											
Sample Date	05/09/2019 16:00	05/09/2019 16:00											
Sample Type	Surface Water	Surface Water											
Batch Number	1	1											
Date of Receipt	05/09/2019	05/09/2019											
Dissolved Arsenic #	<0.9	<0.9									<0.9	ug/l	TM30/PM14
Dissolved Barium #	<1.8	9.0									<1.8	ug/l	TM30/PM14
Dissolved Beryllium	<0.5	<0.5									<0.5	ug/l	TM30/PM14
Dissolved Boron	46	40									<12	ug/l	TM30/PM14
Dissolved Cadmium #	<0.03	<0.03									<0.03	ug/l	TM30/PM14
Dissolved Calcium #	96.6	121.1									<0.2	mg/l	TM30/PM14
Total Dissolved Chromium #	<0.2	<0.2									<0.2	ug/l	TM30/PM14
Dissolved Copper #	5	<3									<3	ug/l	TM30/PM14
Dissolved Lead #	<0.4	<0.4									<0.4	ug/l	TM30/PM14
Dissolved Magnesium #	51.2	33.8									<0.1	mg/l	TM30/PM14
Dissolved Mercury #	<0.5	<0.5									<0.5	ug/l	TM30/PM14
Dissolved Nickel #	121.2	31.4									<0.2	ug/l	TM30/PM14
Dissolved Potassium #	6.6	6.5									<0.1	mg/l	TM30/PM14
Dissolved Selenium #	<1.2	<1.2									<1.2	ug/l	TM30/PM14
Dissolved Sodium #	9.7	10.8									<0.1	mg/l	TM30/PM14
Dissolved Vanadium #	<0.6	<0.6									<0.6	ug/l	TM30/PM14
Dissolved Zinc #	47.0	9.4									<1.5	ug/l	TM30/PM14
Total Hardness Dissolved (as CaCO3)	457	445									<1	mg/l	TM30/PM14
Sulphate as SO4 #	478.2	350.5									<0.5	mg/l	TM38/PM0
Hexavalent Chromium	<0.002	<0.002									<0.002	mg/l	TM38/PM0
Total Dissolved Chromium III	<0.002	<0.002									<0.002	mg/l	NONE/NONE
Total Alkalinity as CaCO3 #	NDP	60									<1	mg/l	TM75/PM0
Sulphide	<0.01	<0.01									<0.01	mg/l	TM107/PM0
Dissolved Iron II	33.75_{AC}	0.14									<0.02	mg/l	TM48/PM0
Dissolved Iron III	1.55_{AC}	0.10									<0.02	mg/l	TM30/TM48/PM0
Manganese II	9.64_{AB}	2.32_{AA}									<0.02	mg/l	TM62/PM0
pH #	3.66	6.29									<0.01	pH units	TM73/PM0

Please see attached notes for all abbreviations and acronyms

Client Name: Smith Grant LLP

Reference: R2762

Location: Brymbo Heritage

Contact: Ben Thomas

Matrix : Liquid

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Method No.	NDP Reason
19/14334	1	FOUNDRY ADIT		1-4	TM75/PM0	Sample pH is acidic and not suitable for this test

Client Name: Smith Grant LLP
Reference: R2762
Location: Brymbo Heritage
Contact: Ben Thomas

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
No deviating sample report results for job 19/14334						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 19/14334

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher, this result is not accredited.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range
AA	x4 Dilution

AB	x10 Dilution
AC	x25 Dilution

EMT Job No: 19/14334

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM14	Analysis of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for dissolved metals and acidified if required.				
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM14	Analysis of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for dissolved metals and acidified if required.	Yes			
TM30/TM48	Calculation of Fe (III) based on Iron and Fe(II)	PM0	No preparation is required.				
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods 325.2 (Chloride), 375.4 (Sulphate), 365.2 (o-Phosphate), 353.1 (TON), 354.1 (Nitrite), 350.1 (NH4+) comparable to BS ISO 15923-1, 7196A (Hex Cr)	PM0	No preparation is required.				
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods 325.2 (Chloride), 375.4 (Sulphate), 365.2 (o-Phosphate), 353.1 (TON), 354.1 (Nitrite), 350.1 (NH4+) comparable to BS ISO 15923-1, 7196A (Hex Cr)	PM0	No preparation is required.	Yes			
TM48	Determination of Ferrous Iron by reaction with Sodium Carbonate and Morfamquat Sulphate which is analysed spectrophotometrically.	PM0	No preparation is required.				
TM62	Determination of Manganese (II) by reaction with Formaldoxime in ammoniacal solution to form a manganese complex which is analysed spectrophotometrically.	PM0	No preparation is required.				
TM73	Modified US EPA methods 150.1 and 9045D and BS1377:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			
TM75	Modified US EPA method 310.1. Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.	Yes			
TM107	Determination of Sulphide/Thiocyanate by Skalar Continuous Flow Analyser	PM0	No preparation is required.				

EMT Job No: 19/14334

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
NONE	No Method Code	NONE	No Method Code				