



East Street, Merthyr Tydfil

Jubb

Table of Contents

EXECUTIVE SUMMARY	5
1 Introduction	8
1.1 Commission	8
1.2 Objectives	8
1.3 Scope, Sources & Limitations	8
2 Site Setting	10
2.1 Site Location	10
2.2 Site Description	10
2.3 Site Proposals	11
3 Previous Reports	12
3.1 Third Party Reports	12
4 Summary of Desk Study Information	13
4.1 Published Geology	13
4.2 Hydrogeology	14
4.3 Hydrology	14
4.4 Landfill Sites	14
4.5 Radon Risks	14
4.6 Site History	15
4.7 Preliminary Risk Assessment (Contamination)	15
5 Ground Investigation Works	18
5.1 General	18
5.2 Exploration Sampling Strategy	18
5.3 Geotechnical Testing	19
5.4 Contamination Testing	19
6 Ground Conditions	21
6.1 Ground Conditions Encountered	21
6.2 Groundwater	21
7 Material Properties	23
7.1 Made Ground	23
7.2 Glacial Till	24
7.3 Lower South Wales Coal Measures	26
8 Generic Quantitative Risk Assessment (Contamination)	27
8.1 General	27
8.2 Risks to Human Health	27
8.3 Risk to Controlled Waters	30

8.4	Risks to Flora and Fauna	31
8.5	Risk to Building Materials	31
8.6	Risks to Adjacent Land and Third Parties	31
8.7	Potential Geo-Environmental Liabilities	31
8.8	Off Site Disposal	31
8.9	Updated Conceptual Site Model	31
8.10	Contamination Risk Summary and Mitigation	33
9	GEOTECHNICAL ASSESSMENT	34
9.1	Introduction	34
9.2	Excavations	34
9.3	Foundation Options	35
9.4	Floor Slabs	35
9.5	Retaining Walls	35
9.6	Protection of Buried Concrete	36
9.7	Earthworks	36
9.8	Soakaway Design	37
9.9	Underground Workings	37
10	GEOTECHNICAL RISK REGISTER	38
11	References.....	42
	Appendix A: Site Location Plan	43
	Appendix B: Proposed Site Development Plan	44
	Appendix C – Exploratory Hole Location Plan	45
	Appendix D: HazWaste Waste Classification Report	46
	Appendix E: - Contamination Risk Assessment Methodology and Definitions	47
	Appendix F - Limitations and exceptions	52

List of Figures

Figure 1: Site Location	10
Figure 2: A Line Plot	24
Figure 3: Glacial Till SPT N Value v Elevation	25
Figure 4: Schematic Cross Section of Proposed Buildings	34
Figure 5: Schematic Geological Section	37

List of Tables

Table 1: Preliminary Conceptual Site Model	17
Table 2: Sampling Strategy	19
Table 3: Contamination Suite.....	19
Table 4: Geotechnical Testing	19
Table 5: Soil Contamination Testing	20
Table 6: Ground Conditions Summary.....	21

Table 7: Monitoring Well Installation Summary	22
Table 8: Groundwater Monitoring Summary	22
Table 9: Particle Size Summary.....	23
Table 10: Atterberg Limit Test Summary	23
Table 11: Particle size distribution testing	24
Table 15: Summary of Soil Contamination – Metals and Semi Metals.....	27
Table 16: Summary of Soil Contamination – PAHs.....	28
Table 17: Gas Monitoring Results.....	30
Table 18 Preliminary Conceptual Site Model.....	32
Table 24: Sulphate Tests Summary	36
Table 19: Compaction Testing.....	37
Table 20: Risk Rating	38
Table 21: Geotechnical Risk Register	39

PROJECT INFORMATION

Project Information

Client Merthyr Tydfil Housing Association

Project Details

Project Name East Street, Merthyr Tydfil

Location Merthyr Tydfil

Jubb Project Number 18219

Title Ground Conditions Assessment Report

Report Details

Version 1

Status First Issue

Date October 2018

Report Authorisation

Prepared By

I Squibbs

Job Title

Senior Engineering
Geologist

Signature



Approved By

A Mitchell

Principal Geotechnical
Engineer



Issue History

Version	Date	Details
1	10/10/18	First Issue minus monitoring visit

EXECUTIVE SUMMARY

Site Information	
Client	Merthyr Tydfil Housing Association
Project	East Street, Merthyr Tydfil
OS Co-ordinates	SO 0671 0781
Site Size	Approximately 60m across the site from east to west and around 45m from north to south.
Proposals	Four two storey houses, six one-bedroom flats and two bungalows, with the proposed buildings along the southern end to be cut into the slope of the site with a retaining wall in front.
Site Description	Site is an open patch of land that slopes down to the south at an average of 15°.
Current and Historic Site Uses	Site historically covered by terraced houses and a public house up until the 1980's when they were all demolished. Site been open land since.
Ground Conditions	
Geology	The site is shown to be underlain by Glacial Till, comprising clay with boulders over the South Wales Lower Coal Measures Formation. A thickness of made ground is also expected associated with its historical past.
Hydrogeology and Hydrology	<u>Hydrogeology</u> The glacial till deposits are classified as an 'Unproductive Stratum' with the Lower Coal Measures being classed as a Secondary 'A' Aquifer. <u>Hydrology</u> The nearest surface water feature is the River Taff Fechan.
Ground Conditions Encountered	▪ Made ground was encountered down to a maximum depth of 2.95m. ▪ Glacial Till encountered beneath made ground ▪ The Lower Coal Measures encountered from a depth of between 16m and 18.5mbgl.
Geo-environmental Assessment	
Contamination Assessment	Elevated lead was found in two samples and one sample exceeded benzo(a)pyrene and benz(a)anthracene slightly exceeding relevant guidelines for human health for residential development.

	Ground gas regime determined as Characteristic Situation 2, based on elevated carbon dioxide levels recorded. The site is in an area where less than 3% of homes are above the Action Level, therefore no radon protection measures are required for the site
Mitigation Measures	In areas where the made ground is to be left in place, in any garden or soft landscaped areas, either the material should be excavated out or a capping later will need to be installed. Standard task specific PPE and good hygiene practices should be adopted by site groundworkers. Gas protection measures will be required for any development at the site, in accordance with recommendation of BS 8485:2015.
Waste Classification	Soils from the site have been assessed in accordance with WM3 and are generally classified as 'Non-hazardous' for disposal purposes, with the exception of one (TP5) which is indicated as 'Hazardous'. WAC testing has been carried on three samples with two of which have indicated elevated organic carbon and would need to be disposed of as 'stable, non-reactive hazardous waste in non-hazardous landfill' should soils be removed to landfill.
Contamination Risk Classification	Contamination risk posed by the site is considered to be low.
Geotechnical Assessment	
Foundations and Floor Slabs	- Strip footings founding at a minimum of 0.75m depth in the stiff to very stiff glacial till, which should be exposed after lowering site levels should be suitable along the southern half of the site. - Over the NW foundations should extend to a depth of 2.1m through made ground and soft clay or a raft foundation should be adopted. - Suspended floor slabs are recommended for the site. - All foundation loads to be taken to a depth outside to the zone of influence of any existing or proposed retaining structures.
Excavations	- Excavations should be suitable with a large excavator. - Obstructions of large boulder and historical foundations should be expected and provisions of dealing with should be made prior to site works. - Temporary excavations should be battered back at an angle of 1:2. If insufficient space to carry out this then cutting should be supported by relevant shoring systems.
Earthworks	- Material from the made ground and glacial till can be classed as 2A&2B cohesive general fill. - Any boulders and detrimental material should be removed if material used as engineered fill.

Buried Concrete Classification	- Concrete placed within the natural strata will have a DS-1 an ACEC class AC-1s, based on the groundwater being static and AC-1 below the groundwater table. - Any concrete that is placed within or has contact with the made ground in the area of TP5 should have a design sulphate class DS-2 and AC-2.
Retaining Walls	- A retaining wall will be required with the retained material will mainly comprise made ground and some glacial till. - The retaining wall should be founded within the stiff to very stiff glacial till clays and should be designed in accordance with Eurocode 7 and BS 8002:2015.
Groundwater	- A groundwater seepage was encountered in TP5 at the base of the made ground. - Groundwater monitoring was carried out and recorded levels of between 0.5m and 4.0m which likely indicates perched water within the made ground.
Historical Underground Workings	- No underground workings, disturbed ground or voids were found during the site works. - An ironstone band was recorded in one borehole at a depth of around 26m below ground level which was approximately 10m below the rockhead level. - No evidence of workings found and given the depth to ironstone agree with previous ESP report that underground working unlikely beneath the site.
Geotechnical Risk Category	Geotechnical Category 2.

1 Introduction

1.1 Commission

Merthyr Tydfil Housing Association are proposing to redevelop a vacant plot of land off East Street, Dowlais, Merthyr Tydfil with the construction of one and two storey residences. To assist with the development of the site proposals, Jubb Consulting Engineers (Jubb) have been appointed to undertake a geotechnical and geo-environmental assessment of the ground conditions.

This report constitutes the Ground Conditions Assessment (GCA) for the proposed development and provides advice for the geotechnical and geo-environmental design of the development and associated ground contamination or geotechnical hazards.

This report is for the private and confidential use of Merthyr Tydfil Housing Association (to whom alone is owed a duty of care) and their professional advisors and consultees; it may not be relied upon or reproduced by any third party for any use without the written agreement of Jubb.

1.2 Objectives

The objectives of this assessment are:

- to assess the geo-environmental ground conditions at the site with due regard to any previous investigation, remediation and validation works undertaken as part of the site enabling works. If necessary, to provide outline recommendations for risk mitigation based on the findings;
- to analyse the intrusive ground investigation results to determine ground conditions, obtain representative values for geotechnical analysis, and identify any geotechnical issues which may affect the proposed development;
- to make an evaluation of any potential environmental or geotechnical hazards, risks and liabilities to the planned development of the site on the basis of the foregoing studies, and to provide engineering and environmental recommendations for the site, in view of the potential development of the site.

1.3 Scope, Sources & Limitations

A Phase 1 Geo-environmental desk study report and Phase 2 Geo-environmental site investigation report were carried out in 2014 and have been provided to Jubb and referenced in the production of this report, as detailed in Section 3.0.

A Ground Investigation was also commissioned to support and supplement the initial assessment of the site, see Section 5.0 for more details.

This report has been carried out in accordance with the following UK legislation and regulatory guidance for site investigations: -

- BS EN 1997-2 (2007) Eurocode 7 Geotechnical design – Part 1 General rules;
- BS EN 1997-2 (2007) Eurocode 7 Geotechnical design – Part 2 Ground Investigation and testing;
- NA to BS EN 1997-1:2004 UK National Annex to Eurocode 7: Geotechnical design – Part 1: General rules,
- NA to BS EN 1997-2:2004 UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing;
- BS 5930 (2015) Code of Practice for site investigations;
- BS 8004 (2015) Code of Practice for Foundations;
- BS 10175 (2011) + A1: (2013) Investigation of Potentially Contaminated Sites – Code of Practice;

- CLR 11 (2004) Contaminated Land Research Report, Defra/EA - Model Procedures for the Management of land contamination;
- BS EN 14688 – 1 (2002) + A1 (2013) Geotechnical investigation and testing. Identification and classification of soil. Identification and description.
- BS EN 14688 – 2 (2004) + A1 (2013) Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification.
- BS EN 14689 – 1 (2003) Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

It should be noted that any ground investigation provides only a small sampling of any site and that ground conditions may differ both laterally (across the site) and vertically (with depth) between sample points. Such differing conditions may thus remain undetected by fieldwork. Certain areas may not have been accessible to intrusive survey due to vegetation, live services or other obstructions.

2 Site Setting

2.1 Site Location

The site is located on a patch of open grassed land off East Street in the village of Dowlais situated approximately 2.5km to the north east of Merthyr Tydfil town centre.

Figure 1: Site Location



The Ordnance Survey (Landranger) grid reference at the centre of the site is SO 0671 0781.

A site location plan and aerial photograph are reproduced in **Appendix A**.

2.2 Site Description

The site is a roughly inverted 'L' shape patch of open land approximately 60m across the site from east to west and around 45m from north to south. The site is covered by grass with a small area of trees and vegetation over the south western corner. The site slopes down to the south with a change in elevation from 313.0mAOD over the northernmost boundary with a lowest level of around 305.5mAOD over the south western corner of the site. The southern half of the site has a distinct slope, sloping at on average at 15° from the horizontal with a maximum slope of 25° recorded.

The site is bounded at its north western end by Upper Union Street and by a single storey Cancer Aid building and associated car park over the eastern half of the northern boundary. The car park is bound by a metal railing fence. East Street forms the southern boundary of the site while Commercial Street runs along the eastern boundary of the site. An on-grade asphalt car park is situated beyond the western boundary associated with the neighbouring Dowlais Library. The library car park is cut into the slope, with stone retaining walls varying in height between

0.5m and 2.0m along the common site boundary. Above the retaining wall the ground slopes at around 15° to the north western area of the site.

2.3 Site Proposals

It is understood that it is proposed to build four two-bedroom houses over the south western part of the site, six one-bedroom flats over two storeys over the south eastern part of the site and two single storey bungalows over the north western area of the site.

From the proposed layout drawing (Project No. 18219, Dwg No. SK1, Rev P2, dated 11.7.18), the proposed finished floor levels (FFL) vary from 306.0mAOD over the south western corner to 307.1mAOD over the south eastern area. The bungalows have a finished floor level of 311.45mAOD.

The change in levels from the north and southern sides of the site will be accommodated by a 2.0m to 3.0m high retaining wall, the exact design is still to be determined, with a second retaining wall being built over the north western boundary.

A site proposal plan is included in **Appendix B**.

3 Previous Reports

3.1 Third Party Reports

The following information has been made available to aid with the composition of this report. Where relevant, data has been used from these sources and used to supplement information gained from the current phase of the works.

The reports are as follows:

- Earth Science Partnership (ESP), Proposed Residential Development, East Street, Dowlais, Desk Study and Preliminary Risk Assessment Report. (Report No. 6626e/2885, dated June 2017).

3.1.1 Earth Science Partnership, Desk Study and Preliminary Risk Assessment Report. (Report No. 6626e/2885, dated June 2017)

A desk study for the site was undertaken by ESP, the main findings are summarised below with a more detailed analysis carried out in Section 4.

- Site originally covered by residential housing and a public house until demolished by the 1980's.
- Iron Works located 150m to the north and to the south of the site until the 1950's.
- Coal Authority Report indicates site likely within zone of influence of potential underground ironstone workings.
- Moderate risk of contamination on site from historical sources.
- High risk of ground gas from on-site made ground historical backfilled workings to south of site.

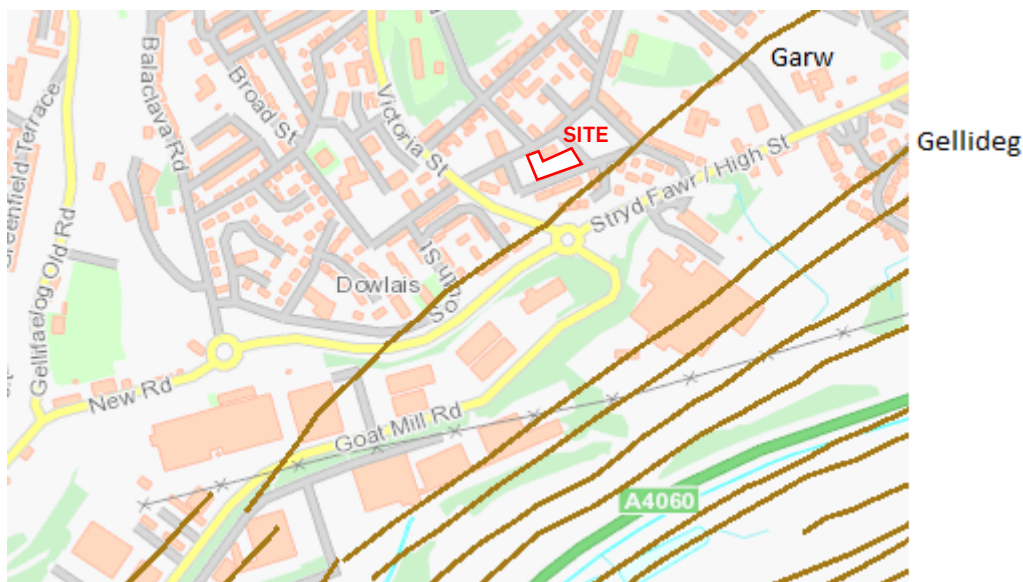
4 Summary of Desk Study Information

4.1 Published Geology

The Geological Survey of Great Britain (Sheet 231, Scale 1: 50,000) and BGS Online Viewer, shows the site to be underlain by Glacial Till comprising sandy clay with boulders. The solid geology beneath the site is the South Wales Lower Coal Measures Formation, which is described as coal bearing mudstones and siltstones. The base of the coal measures is marked by the 'Farewell Rock' described as sandstones with subordinate shale and marks the end of the productive coal measures and the start of the Milstone Grit. The rocks are shown to dip at between 8° to 16° down to the south east.

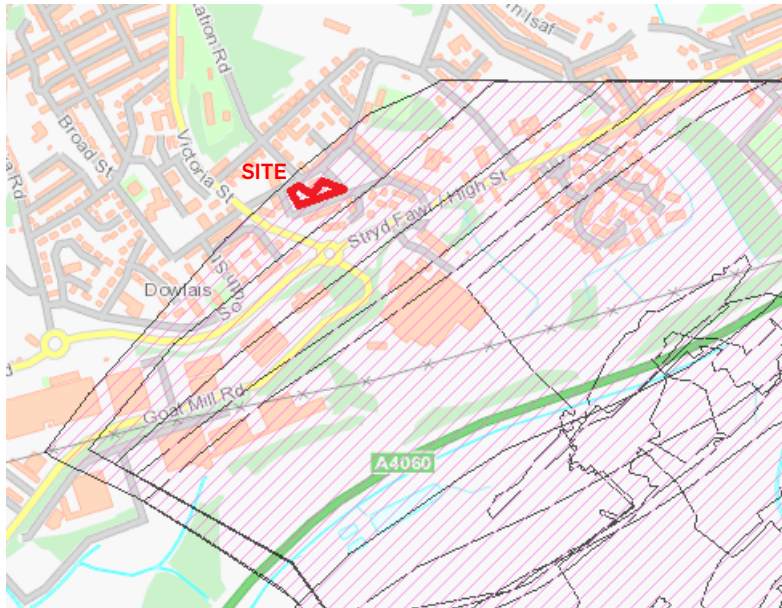
The geological map indicates that the Garw coal seam is the lowest worked seam, with other seams below thin and generally impersistent. The Garw coal seam has a recorded thickness of 0.45m within the Taff Valley. The Gellideg is the lowest of three closely spaced coals and is recorded between 0.6m and 0.9m in thickness.

The Coal Authority Interactive Map is shown below with the coal outcrops shown below, with the assumed names of the nearby coal seam outcrops.



Tabular and nodular ironstones distributed through the measures between the Garw and Gellideg were worked from patchworks and shallow mines. The Coal Authority Interactive Viewer indicates the site to be just within an area of historical shallow underground mining with the Coal Authority Report stating the property is in an area that could be affected by underground mining of ironstone at shallow depth, last worked in 1878.

The earliest historical maps show that the site was covered by properties in 1875, which again reduces the likelihood of workings beneath the site as a lot of superficial soils would have had to be excavated to get to the crop.



The Rosser Ironstone seam occur in conjunction with the Garw coal seam and according to the Geological Survey Memoirs occurs as nodules within shale bed which was recorded as being 7.6m thick in the Dowlais Area.

According to the ESP report the mine workings in the area are recorded to have been worked from the crop, indicating that the seam would be worked from where it outcrops so unlikely to have been worked under the site.

4.2 Hydrogeology

The glacial till deposits are classified as an 'Unproductive Stratum' with the Lower Coal Measures being classed as a Secondary 'A' Aquifer.

Secondary 'A' aquifers are classed as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases, form an important source of base flow to rivers. Unproductive stratum is described as rock or drift deposits with low permeability that have a negligible significance for water supply or base river flow.

The site is not within a Source Protection Zone.

The site is within an area indicated to be at risk from groundwater flooding.

4.3 Hydrology

The nearest surface water feature is the River Taff Fechan which flows from north to south approximately 3km to the west of the site.

4.4 Landfill Sites

No landfill sites have been identified within 400m of the site from the Phase 1 desk study although large areas of made ground have been identified to the north and south of the site associated with the historical industrial past.

4.5 Radon Risks

The site is in an area where less than 1% of the properties are above the Action Level, therefore no radon protection measures are required for the site.

4.6 Site History

The earliest map (1875) shows the site to be covered by residential houses and two public houses, around the perimeter with gardens and lawns over the central areas of the site, up until 1983 when the site is now shown to be vacant.

Much of the surrounding industry was dominated by coal and ironstone workings with Dowlais Ivor Iron Works located 310m to the north with associated stables 50m to the north east and railway station and sidings 150m to north west. Dowlais Iron Works was located 200m to the south of the site and closed in 1935, with the OP chocolate factory operating on its former ground to this present day.

4.7 Preliminary Risk Assessment (Contamination)

The following section provides a Preliminary Risk Assessment (PRA) of contamination at the site and develops an initial Conceptual Site Model (CSM) to establish whether there are any potentially unacceptable risks associated with proposed development at the site.

The CSM provides a method to characterise potential site risks, by outlining potential sources of contamination, identifying potential receptors that may be impacted, and determining potential pathways by which sources may affect receptors.

The following preliminary CSM has been derived from an assessment of the site's environmental setting, site history, and review of previous reports.

The Risk Assessment Methodology and Definitions are set out in **Appendix E** to this report.

4.7.1 Potential Sources of Contamination

The potential contaminants described below have been identified from a study of the site history. The principal contaminative sources are as follows:

On-Site

- Heavy metals and PAH within made ground from previous/historic development.
- Ground gas

Off-Site

- Historical Iron Works
- Railway Sidings
- Various surrounding historical industrial processes

4.7.2 Potential Receptors

The following potential receptors have been identified, based on the proposed development of the site for residential purposes:

- Ground workers and construction workers;
- Future residents;
- Groundwater (Principal Aquifer);
- Building materials

4.7.3 Preliminary Conceptual Site Model (CSM)

The potential key contaminative substances, potential receptors and possible pathways were set out by ESP in the desk study and are shown in the table below, assuming a worst-case scenario.

This preliminary CSM will be used to target the require site investigation and will be developed and refined, based on the results of the site investigation.

Table 1: Preliminary Conceptual Site Model

Preliminary Conceptual Site Model						
Sources	Receptor	Pathway	Consequence	Probability	Risk	Recommended Action (to clarify level of risk and assess suitable mitigation measures or to mitigate the risk)
Heavy metals from on-site sources	Future Site Users;	Human uptake pathways	Medium	Likely	Moderate risk	Site Investigation will be required to determine contamination potential of site soils, presence of made ground etc. Future mitigation measures to protect human health may be required depending upon results (capping, soil treatment, etc.). Use of suitable PPE and good hygiene practice on the site to mitigate risk.
	Construction workers;	Human uptake pathways	Minor – Standard PPE sufficient	Likely	Moderate/Low risk	
	Groundwater	Percolation/ leaching/ migration to groundwater;	Medium	Likely	Moderate risk	
Organics/PAH/ Hydrocarbons from made ground	Future Site Users;	Human uptake pathways	Medium	Likely	Moderate risk	Site Investigation will be required to determine contamination potential of site soils, presence of made ground etc. Future mitigation measures to protect human health may be required depending upon results (capping, soil treatment, etc.). Use of suitable PPE and good hygiene practice on the site to mitigate risk.
	Construction workers;	Human uptake pathways	Minor	Likely	Moderate/Low risk	
	Groundwater	Percolation and leaching to groundwater;	Medium	Likely	Moderate risk	
	Surface Water	Leaching	Medium	Low	Moderate risk	
Sulphates and pH	Building Materials	Contact with subsoil or groundwater	Mild	High	Moderate risk	Suitable site investigation to quantify risk, specify concrete classification accordingly;
Asbestos potentially in made ground	Future Site Users;	Inhalation	Medium	Low likelihood	Moderate risk	Sample shallow soils
	Construction workers; Demolition workers.	Inhalation	Medium	Low likelihood	Moderate risk	
Ground Gases	Future Site Users;	Inhalation	Severe	Likely	High risk	Potential for ground gases from made ground and underground workings.
	Construction workers.	Inhalation	Severe	Likely	High risk	
Radon	Future Site Users;	Inhalation	Medium	Unlikely	Low risk	

5 Ground Investigation Works

5.1 General

A ground investigation was undertaken by Terra Firma (South) after being scoped by Jubb. The ground investigation comprised window sampling, trial pitting and rotary open hole boreholes. The site works were carried out between the dates 20 August and 8 September 2018.

The site investigation works comprised:

- Five window sampling boreholes.
- Six machine excavated trial pits.
- Three rotary open hole boreholes.

The exploratory hole locations were decided by Jubb, based on the previous investigation exploratory hole locations and the outline of the development proposal, with holes being moved accordingly with regards to site constraints at the time of the siteworks.

The exploratory hole locations were checked for buried services prior to excavation and each location was scanned by Terra Firma using a cable avoidance tool (CAT).

Representative soil sampling of each stratum was undertaken to allow geotechnical and chemical testing.

The factual ground investigation works are detailed in the following report:

- Terra Firma Factual Ground Investigation Report, Report No. 6211, dated September 2018.

5.1.1 Window Sample/Dynamic Probe Holes

Five window sample holes (WS1 to WS5) were drilled to depths of up to 5m. Disturbed samples were taken at close intervals during boring in order to give a comprehensive record of strata encountered. SPT's were carried out at regular intervals during drilling to allow an assessment of in-situ density or stiffness of the ground. Where strata allowed, disturbed samples were collected on which to perform geotechnical laboratory tests.

5.1.2 Trial Pits

Six trial pits (TP1 to TP6) were excavated using a 6-tonne tracked excavator and extended to depths of between 0.6m and 3.3m below existing ground levels. After detailed examination, measurement and sampling, the excavations were backfilled with arisings and compacted in layers using the machines bucket.

5.1.3 Rotary Open Boreholes

Three rotary open probe holes were carried out using a Beretta T44 drilling rig down to a maximum depth of 30m. The holes were drilled using a down-hole hammer with water mist as a flush medium.

5.2 Exploration Sampling Strategy

A site walkover was undertaken by Jubb while the site investigation was being undertaken, and the existing site conditions inspected. This walkover, in combination with the review of site history and previous ground investigations that had taken place on the site previously, allowed the investigation to be targeted as follows:

Exploratory Hole	Notes/Rational
WS1 to WS5	Window samples were positioned for general site coverage and sampling of the made ground and shallow superficial deposits, as well as allow the installation groundwater and ground gas monitoring wells.

TP1 to TP6	Trial pits were positioned for general site coverage and sampling of any made ground and shallow superficial deposits.
BH1 to BH3	Boreholes drilled within the area of proposed buildings to check for underground workings and voids.

Table 2: Sampling Strategy

The sampling strategy was based on obtaining sufficient samples from across the site. Relevant samples were submitted for a general 'brownfield' suite of testing, determinants as detailed below.

Suite	Determinants
General Contamination Suite	As, Cd, Cr, Cu, Pb, Ni, Se, V, Zn, Hg, pH, B, Cr(III), Cr(IV), PAH's and Speciated Hydrocarbons (C10-C40), TOC and Asbestos screening

Table 3: Contamination Suite

5.3 Geotechnical Testing

An initial phase of geotechnical testing was carried out by I2 Analytical Ltd in accordance with *BS1377: Methods of test for soils for civil engineering purposes*, as listed in the table below.

No. of Tests	Test	Test Method
Classification Tests		
6	Liquid and plastic (Atterberg) limits.	BS1377: Part 2.
2	Particle Size Distribution Sieving	BS1377: Part 2.
Compaction Tests		
1	Dry Density/OMC with 2.5kg rammer	BS1377: Part 4
Shear Strength Tests		
1	Shear Box	BS1377: Part 7
Chemical Test: Soil		
4	Water soluble sulphate, total (acid soluble) sulphate and total sulphur contents and pH value.	BRE SD 1

Table 4: Geotechnical Testing

5.4 Contamination Testing

The geo-environmental testing was carried out by DETS Ltd, a UKAS and MCERTS accredited laboratory. Sub-samples were taken from the exploratory holes and placed in appropriate environmental containers before being sent by courier to the laboratory in cool boxes. The number of soil and leachate samples tested are summarised in the table below:

Exploratory Hole	Depth (mbgl)	Analysis Undertaken
TP1	0.4	General Suite + WAC
TP2	0.6	General Suite +WAC
TP4	0.3	General Suite + WAC
TP5	0.6	General Suite
WS1	0.5	General Suite
WS2	1.1	General Suite
WS5	0.6	General Suite

Table 5: Soil Contamination Testing

6 Ground Conditions

6.1 Ground Conditions Encountered

The ground conditions are summarised in the table below:

Description	Stratum	Encountered in	Depth range to top of stratum (m bgl)	Depth range to base of stratum (m bgl)	Average thickness (m)
Soft to firm grey brown slightly sandy gravelly CLAY, low cobble and boulder content	Made Ground	All Exploratory Holes	GL	0.85-2.95	1.8
Stiff to very stiff gravelly CLAY with low to medium boulder content	Glacial Till	All Exploratory Holes except TP1	0.85-2.95	>5.0m	-
Mudstone/Sandstone	Lower Coal Measures	BH1 to BH3	16.0	18.5	>21.5m
Ironstone	Lower Coal Measures	BH2	26.2	27.8	1.6m

Table 6: Ground Conditions Summary

6.1.1 Made ground

Made ground was encountered in all exploratory holes across the site and generally consisted a soft to firm dark grey brown sandy gravelly clay extending down to a maximum depth of 2.95m in TP1. The made ground generally included brick, tile, ash and concrete with sandstone boulders and old brick foundations noted in areas.

6.1.2 Glacial Till

Glacial till was encountered beneath the made ground and generally comprised stiff to very stiff slightly sandy gravelly clay. A large number of sub-rounded sandstone and limestone boulders were present within the till making excavating conditions very difficult. The till was encountered to the base of every exploratory hole with it extending to a depth of at least 5mbgl.

In TP4 the glacial till appeared sandier in nature and was very stiff, this was carried out in the area where there was a collection of trees so was root affected.

In TP5, beneath the made ground was a soft greenish grey clay layer that had a distinctive organic odour. A blackened tree stump was encountered at 1.8mbgl within this layer and a groundwater seepage occurred around this. This layer extended to a depth of 2.1m before the more typical stiff till material was encountered.

6.1.3 Lower Coal Measures

The Lower Coal Measures were encountered in the deeper boreholes at depths of between 16.0m and 18.5m below ground level and were described as interbedded sandstone and mudstone units. BH2 recorded an ironstone layer at between 26.2m and 27.8m below ground level.

During the drilling no observed voids or areas of low resistance were noted.

6.2 Groundwater

Groundwater was only encountered within TP5 and occurred as a minor seepage at the base of the made ground at 1.30m, with a second seepage noted at a depth of 1.8m around a tree stump. The deeper seepage could have been from a disused pipe/drain being struck, although no pipe fragment was seen, and no known services crossed the site in that area. The inflow of groundwater had ceased after around 10 minutes of inflow into the pit.

Groundwater monitoring standpipes were installed in three of the window sample holes and three fortnightly monitoring visits were undertaken. The results of the monitoring visits are shown in the table below.

Borehole ID	Groundwater Depth (mbgl)	Installation depth (mbgl)	Reported response zone (mbgl)
WS2	Dry	5.0	1.0-4.0
WS4	Dry	2.0	1.0-2.0
WS5	Dry	3.0	1.0-3.0

Table 7: Monitoring Well Installation Summary

Exploratory Hole	Groundwater Depth(mbgl)		
	10/9/18	02/10/18	TBC
WS2	4.0	3.05	
WS4	0.5	1.10	
WS5	2.5	2.5	

Table 8: Groundwater Monitoring Summary

At the time of writing the report only two monitoring visit had been undertaken. Groundwater was recorded at depths of between 0.5m and 4.0m below ground. The recorded levels probably indicate that there are seepages within the made ground and accumulate at the base of the standpipe where the clay material prevents ground water infiltrating the ground.

7 Material Properties

7.1 Made Ground

7.1.1 Classification Properties

Seven SPT tests were carried out within the made ground and returned SPT N values of between 4 and 50, the higher values represent refusal on the cobble or boulders within the fill. One particle size distribution test and one plasticity test were carried out on the material the results are summarised below.

Particle Size	%
Cobbles	0
Gravel	15.3
Sand	30.8
Silt/Clay	53.9

Table 9: Particle Size Summary

	%
Natural Moisture Content	21
Liquid Limit	36
Plastic Limit	25
Plasticity Index	11

Table 10: Atterberg Limit Test Summary

The PSD tests shows the material will be described as a slightly gravelly slightly sandy CLAY/SILT with the plasticity limit test (shown on Figure 2) showing the material to be verging on a silt. Although not included in the test, the material was witnessed to contain a low cobble and boulder content. The plot shows the material to be of intermediate plasticity and having a low volume change potential with changes in moisture content.

The below properties have been obtained based on known correlations with SPT N values. Given the low number of tests and variable SPT results, the lowest 25th quartile N value of 6 has been used to provide conservative characteristic values.

Characteristic Property	Symbol	Units	Characteristic Values	Source
Unit Weight	γ	kN/m ³	17	5
Angle of Shearing Resistance	ϕ	Degrees	31	2
Undrained shear strength	Cu	kPa	36	1
Modulus of Elasticity	E	MPa	5.2	4
Coefficient of Compressibility	M_v	M ² /MN	0.191	3

- 1 Stroud and Butler, The Standard Penetration Test and the Engineering Properties of Glacial Materials, 1975 Conf. of the Midlands Geotechnical Society.
- 2 Gibson, Experimental Determination of the True Cohesion and True Angle of Internal Friction in Clays, Proc. of the Third Int. Conf. on Soil Mechanics and Foundation Engineering, Zurich, 1953.

- 3 Stroud, M. A., The standard penetration test in insensitive clays and soft rocks, Proc. Europ. Symp. Pen. Testing, Stockholm, 1974
- 4 $E=1/mv$
- 5 BS 8004:2015 for low plasticity clay.

7.2 Glacial Till

7.2.1 Classification Properties

Five plasticity tests were carried out on the cohesive material from the glacial till deposits and the results are summarised below.

	Minimum	Maximum	Average
Natural Moisture Content	11	23	15
Liquid Limit (LL)	34	36	36
Plastic Limit (PL)	18	20	19
Plasticity Index (PI)	15	18	17
Modified PI	12	14	13

Table 11: Particle size distribution testing

:

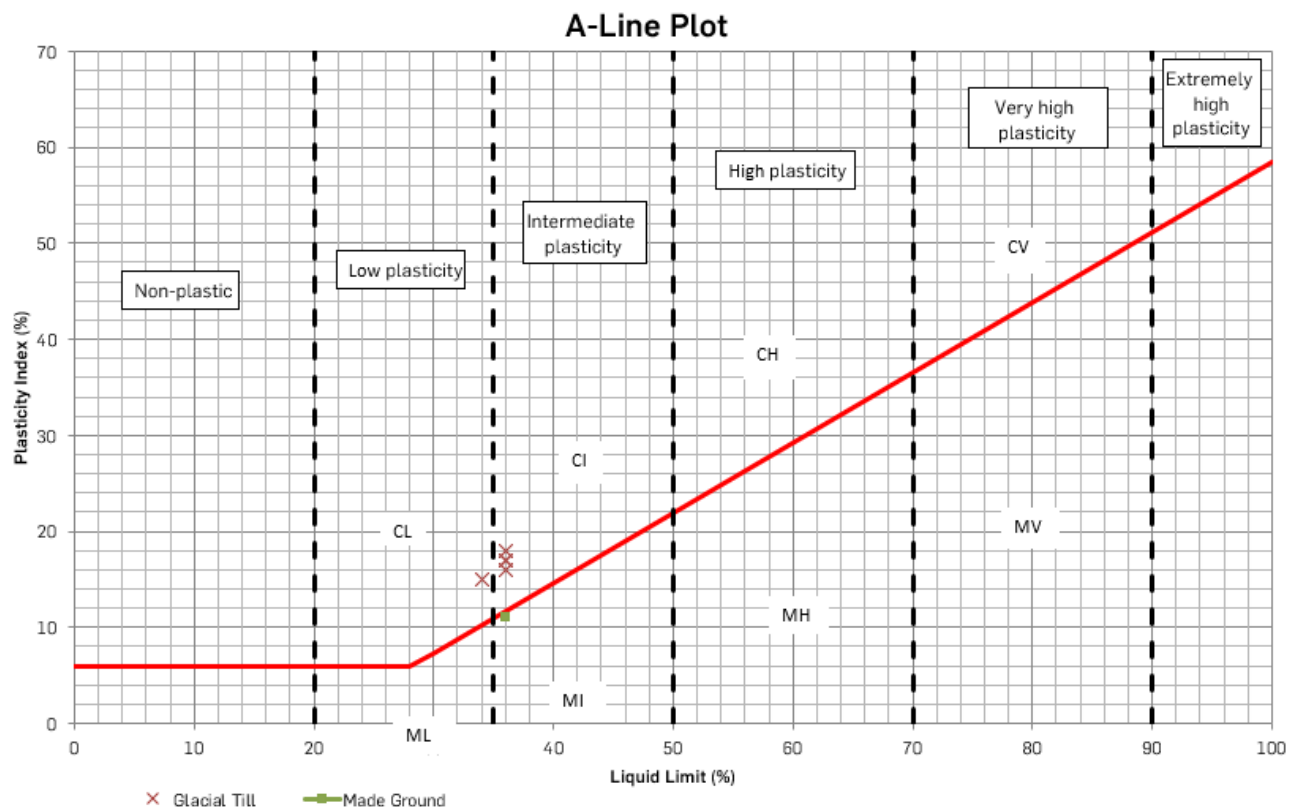


Figure 2: A Line Plot

The soils tested have all shown a small spread of results and are classed as having an intermediate to low plasticity indicating a low volume change potential with changes in moisture content.

Nine SPT tests were carried out with the glacial till and recorded N values of between 15 and 50, the plot of SPT value versus elevation (Figure 3) shows no discernible pattern, with the results likely to be affected by the cobble and boulder content within the fill. The average SPT N value is 35, with the lowest quartile N value of 28. Based on the CIRIA Report C504 Engineering in Glacial Till, the recommended undrained shear strength can be

correlated from SPT N values using the formula $C_u = 5.2 \times N$, which will give undrained shear strengths of between 78kPa and 250kpa indicating the material is stiff to very stiff in strength.

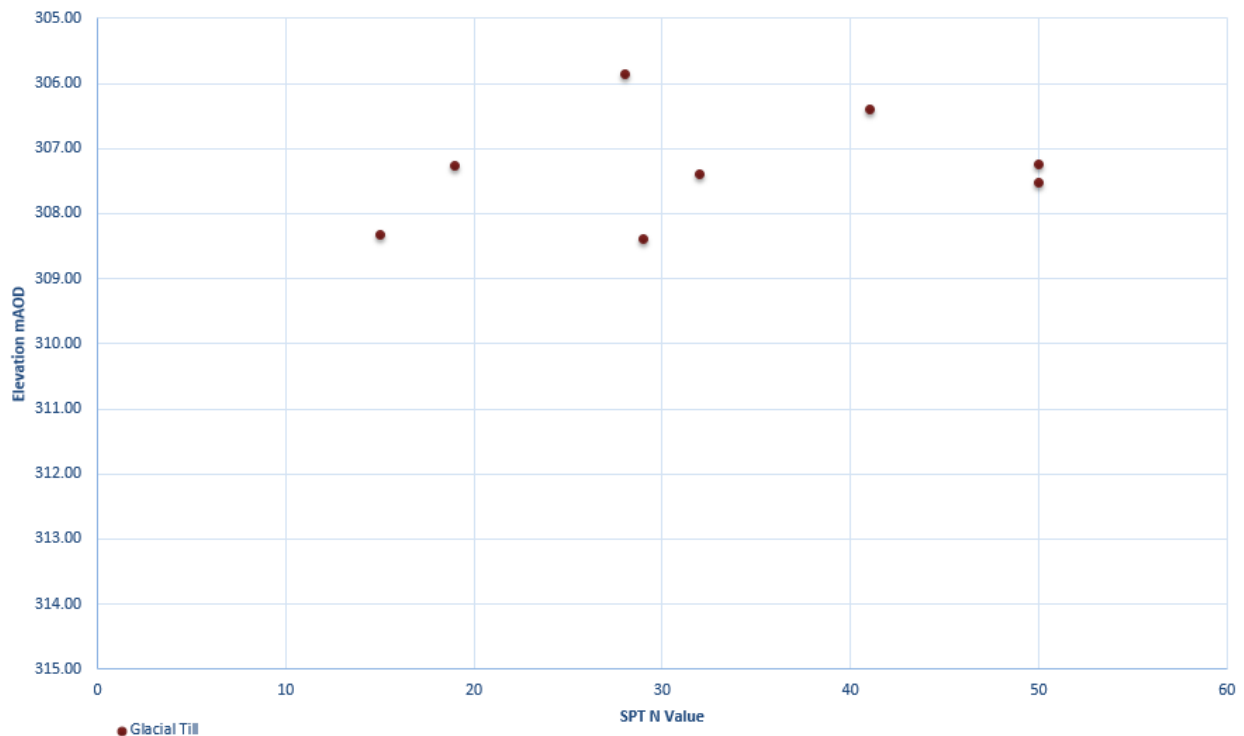


Figure 3: Glacial Till SPT N Value v Elevation

The below table recommends the characteristic geotechnical properties for the glacial till deposits encountered across the site.

Characteristic Property	Symbol	Units	Characteristic Values	Source
Unit Weight	γ	kN/m ³	18	5
Effective Angle of Shearing Resistance	ϕ'	Degrees	28	2
Effective Cohesion	c'	kN/m ²	13	2
Undrained shear strength	C_u	kPa	80	1
Modulus of Elasticity	E	MPa	16.9	4
Coefficient of Compressibility	M_v	M ² /MN	0.059	3
Maximum Dry Density	MDD	Mg/m ³	1.97	1
Optimum Moisture Content	OMC	%	12	1

- 1 Stroud and Butler, The Standard Penetration Test and the Engineering Properties of Glacial Materials, 1975 Conf. of the Midlands Geotechnical Society.
- 2 Shear Box Laboratory Testing .
- 3 Stroud, M. A., The standard penetration test in insensitive clays and soft rocks, Proc. Europ. Symp. Pen. Testing, Stockholm, 1974
- 4 $E=1/m_v$
- 5 BS 8004:2015 for low plasticity clay.

7.3 Lower South Wales Coal Measures

No laboratory testing or in-situ testing has been carried out on this deposit and it is considered the bedrock occurs at a sufficient depth below the proposed levels as to not influence the design, other than the influence of any potential underground mining, which is discussed in Section 9.9, therefore no material properties have been derived for the formation.

8 Generic Quantitative Risk Assessment (Contamination)

8.1 General

The following comprises a Generic Quantitative Risk Assessment (GQRA) of contamination risk, in accordance with the methodology set out in **Appendix E**.

The following updated conceptual model information has been taken from the information obtained in **Section 4.0 - 5.0** and from the site walkover. Contamination testing carried out during the ground investigation has been used to supplement the preliminary conceptual model presented in **Section 4.0**.

8.2 Risks to Human Health

8.2.1 Soils

A summary of the chemical test results and a comparison against the relevant assessment criteria used in this case, are given in the tables below.

The generic assessment criteria used in this case are generally the LQM/CIEH Suitable 4 Use Levels (S4ULs), based on minimal or tolerable risk and are intended to be protective of human health. Different criteria are provided for a variety of land use, and the criteria for "Residential with plant uptake" has been adopted here.

The exception to this is use of the C4SL levels for Lead, as S4UL are not provided for this substance.

Both the C4SL and S4UL are based on current best practice and reflect the most up to date guidance and legislation.

In accordance with best practice, individual exceedances of the relevant assessment criteria have been identified and comment provided where necessary.

The table below summarises the chemical results for metals and semi-metals on site from both phases of investigation:

Table 12: Summary of Soil Contamination – Metals and Semi Metals

Contaminant	C4SL/ S4UL mg/kg	Source	Measured concentrations mg/kg		95% UCL***	Number of individual exceedances
			Minimum	Maximum		
Arsenic (mg/kg)	37	S4UL	11	33	-	0/6
Cadmium (mg/kg)	11	S4UL	0.14	0.63	-	0/6
Chromium (mg/kg)	910	S4UL	17	23	-	0/6
Lead (mg/kg)	86		25	280	166	2/6 TP5 @ 0.6 TP4@0.3
Mercury (mg/kg)	40	S4UL	<0.1	0.98	-	0/6

Selenium (mg/kg)	250	S4UL	0.20	1.4		0/6
Copper (mg/kg)	2400	S4UL	20	180	-	0/6
Nickel (mg/kg)	130	S4UL	22	32	-	0/6
Zinc (mg/kg)	3700	CIEH	55	390	-	0/6
Total PAH (mg/kg)	-	-	<2.0	39	-	0/6
Total Cyanide (mg/kg)	480	CLEA	<0.5	<0.5	-	0/6
Phenol (mg/kg)	3200	CLEA	<0.3	<0.3	-	0/6
Organic Matter (%)	-	-	2.4	22	-	-
pH	6-9	-	7.9	8.3	-	-

- CLEA – Soil guideline values for commercial/industrial development
- CIEH – Chartered Institute of Environmental Health Land Quality Management Generic Assessment Criteria (based upon worse-case 1% SOM content) for commercial development
- GAC – generic assessment criteria calculated using the CLEA model
- PAH – Poly-Aromatic Hydrocarbons
- BRE – Building Research Establishment – Considered in concrete aggressive assessment.
- - Sulphate considered in assessment of concrete environment.
- *** 95% Upper Confidence Limit (UCL) statistical analysis not undertaken where there are no contaminant exceedances and/or insufficient number of samples
- - No comparable target concentration / guideline value
- A total of six representative soil samples were tested for these substances

With the exception of lead, no metal and semi-metal exceedances were encountered on site. Lead was found to be elevated in two samples:

- TP4 at 0.3m = 94mg/kg
- TP5 at 0.6m = 280mg/kg

A 95% upper confidence limit (UCL) is used to estimate an average distribution of contaminant across a site. The 95% UCL value for lead was calculated as 166mg/kg, which makes one sample to still be above the screening value for residential end use.

Table 16 below summarises the results for speciated PAHs on site.

Table 13: Summary of Soil Contamination – PAHs

Contaminant	SGV/ GAC (mg/kg)	Source	Measured concentrations (mg/kg)		95% UCL ***	Number of individual exceedances
			Minimum	Maximum		
Acenaphthene	85000	CIEH	<0.1	0.34		0/6
Acenaphthylene	8210	CIEH	<0.1	0.23		0/6
Anthracene	2300	CIEH	<0.1	1.1		0/6
Benz[a]anthracene	3.1	CIEH	<0.1	3.4	1.73	1/6

						TP4 @ 0.3m
Benzo[a]pyrene	0.83	CIEH	<0.1	2.6	1.33	1/6 TP4@0.3m
Benzo[b]fluoranthene	5.6	CIEH	<0.1	5.0		0/6
Benzo[ghi]perylene	44	CIEH	<0.1	2.3		0/6
Benzo[k]fluoranthene	8.5	CIEH	<0.1	1.7		0/6
Chrysene	6	CIEH	<0.1	4.7		0/6
Dibenz[ah]anthracene	0.76	CIEH	<0.1	0.68		0/6
Fluoranthene	260	CIEH	<0.1	6.1		0/6
Fluorene	160	CIEH	<0.1	0.36		0/6
Indeno[123-cd]pyrene	3.2	CIEH	<0.1	2.0		0/6
Naphthalene	1.5	CIEH	<0.1	0.64		0/6
Phenathrene	92	CIEH	<0.1	2.6		0/6
Pyrene	54000	CIEH	<0.1	5.1		0/6

Notes:

- CIEH – Chartered Institute of Environmental Health Land Quality Management Generic
- Assessment Criteria (based upon worse-case 1% SOM content)
- *** 95% Upper Confidence Limit (UCL) statistical analysis not undertaken where there are no contaminant exceedances and/or insufficient number of samples
- - 95% Upper Confidence Limit (UCL) statistical analysis not undertaken on contaminants with 0 exceedances and/or insufficient number of samples
- A total of six samples were tested for these substances

One sample of Benzo[a]pyrene and one sample of Benz[a]anthracene slightly exceeded the guideline values in TP4 at 0.3m with all the other determinands tested to be below the relevant guidelines. Both of these samples are below their respective 95% UCL value suggesting that these are just outliers and the site as a whole should not be treated as contaminated.

Risks to human health are considered to be low. Current site proposals in the area of TP4 shows the house in this area to be cut into the slope so is likely that this material will be excavated out as part of lowering the site. Where material is left in place and in the areas of TP5 some limited form of capping may be required in garden or soft landscaped areas.

8.2.2 Ground Gas

Gas monitoring wells were installed in three of the boreholes and three fortnightly monitoring visits were carried out, the results of which are shown in the below table:

Table 14: Gas Monitoring Results

Date	Hole Position	Atmos. Press. (mb)	Max Gas Flow (l/hr)	Water Depth (mbgl)	Max Carbon Dioxide (%/vol)	Max Methane (%/vol)	Max Oxygen (%/vol)	Max Hydrogen Sulphide (%/vol)	Max Carbon Monoxide (%/vol)
10/9/18	WS2	982	0.0	4.0	6.6	0.0	17.1	0.0	0.0
	WS4	982	-2.1	0.5	1.2	0.0	20.1	0.0	0.0
	WS5	982	0.1	2.5	10.8	0.0	12.7	0.0	0.0
2/10/18	WS2	986	0.1	3.05	7.8	0.0	10.1	0.0	0.0
	WS4	986	0.3	1.10	3.9	0.0	17.3	0.0	0.0
	WS5	986	0.2	2.5	1.6	0.0	20.8	0.0	0.0
TBC									

A maximum Carbon Dioxide concentration of 10.8% with a flow rate of 0.3l/hr has been identified in WS5. These values equate to a maximum gas screening value of 0.0324 l/hr which is in Characteristic Situation 1 from CIRIA R149 with a **very low risk** classification. However, as some carbon dioxide levels have been recorded to be greater than 5% and given the amount and nature of made ground on the site, then it is recommended that this is increased to Characteristic Situation 2 giving a **low risk** classification or an Amber 1 classification according to the Traffic Light System which the NHBC recommends using for low-rise residential housing.

Based on this classification, low level ground gas protection measures are required using a membrane and ventilated sub-floor void and should be installed as prescribed in BRE 414.

8.2.3 Radon

The site is in an area where less than 3% of homes are above the Action Level, therefore no radon protection measures are required for the site.

8.2.4 Asbestos

Asbestos testing was carried out on six samples taken from the made ground and no asbestos was detected in any of the samples.

8.3 Risk to Controlled Waters

Due to the lack of significant contamination encountered on site during the site investigation works, no testing of groundwater or leaching potential has been carried out.

Given the considerable thickness of glacial till which is classed as an unproductive stratum, this would help reduce any leaching of residual contamination to any groundwater. Groundwater was not encountered during the works so is expected to be at a considerable depth, which coupled with the relative negligible contamination encountered in the site soils during the investigation works, risks to controlled waters are considered to be very low and are not considered further.

8.4 Risks to Flora and Fauna

No significant risk to flora or fauna, in terms of contamination, have been identified at the site.

Appropriate measures will need to be adopted to ensure any proposed soft landscaping areas are suitable for plant growth, including provision of a suitable topsoil layer, suitable importation and testing of topsoil (if required), and testing and validating of any site soils to be re-used to ensure they are fit for plant growth

8.5 Risk to Building Materials

The principal risk to building materials include the potential for corrosive conditions within the site soils, which could impact concrete and below ground structures.

BRE SD1 testing was carried out on the six samples of site soils, and classification for the site is outlined in section 9.5.

8.6 Risks to Adjacent Land and Third Parties

No significant risk to neighbouring occupiers has been identified.

8.7 Potential Geo-Environmental Liabilities

Potential geo-environmental liabilities under Part 2A of the Environmental Protection Act 1990 (as amended) and the Groundwater Regulations (GWR) 2009, relating to the site in its current condition is not considered likely based on the tests data available.

8.8 Off Site Disposal

A waste assessment of the soils in accordance with WM3 has been undertaken in order to support further decisions regarding material movement at the site. All samples tested, with the exception of one sample were classified as non-hazardous using HazWasteOnline web-based software.

The sample from TP5 at 0.6m was recorded as Hazardous Waste due to an elevated zinc concentration which has given it a HP7; Carcinogenic hazard property.

Waste Acceptance Criteria (WAC) testing was carried out on three samples from the within the non-hazardous samples within the made ground and because of slightly elevated Total Organic Content (TOC) levels two of the three samples would be accepted into stable, non-reactive hazardous waste in non-hazardous landfill, with one sample falling within the inert criteria.

The waste classification reports for each sample tested are contained in **Appendix D**.

8.9 Updated Conceptual Site Model

Table 18 below shows the updated conceptual site model, which has been formulated based on the information obtained in the ground investigation and historic data.

Table 15 Preliminary Conceptual Site Model

Sources	Receptor	Pathway	Consequence	Probability	Risk	Recommended Action (to clarify level of risk and assess suitable mitigation measures or to mitigate the risk)
Heavy metals from on-site made ground	Future Site Users	Human pathways uptake	Medium	Low likelihood	Moderate/Low risk	SI indicates some limited contamination, so removal or capping of one area required.
	Construction Workers		Mild	Low likelihood	Low risk	Use of suitable PPE and good hygiene practice on the site to mitigate risk.
	Groundwater	Percolation/leaching migration	Medium	Unlikely	Low risk	No groundwater encountered, Clay site soils will restrict infiltration.
Organics/PAH/ Hydrocarbons from made ground.	Future Site Users	Human pathways uptake	Medium	Unlikely	Low risk	SI indicates limited PAH exceedances, area likely to be reduced in level therefore removing risk.
	Construction workers		Minor	Low likelihood	Very Low risk	Use of suitable PPE and good hygiene practice on the site to mitigate risk.
	Groundwater	Percolation and leaching to groundwater;	Medium	Unlikely	Low risk	No groundwater encountered, Clay site soils will restrict infiltration.
Sulphates and pH	Building Materials	Contact with subsoil or groundwater	Medium	Low likelihood	Low risk	Design Sulphate Class DS-1, Aggressive Chemical Environment for Concrete Class AC-1 and class DS-2 and AC-2 if in contact with made ground.
Asbestos potentially in made ground	Human Health;	Inhalation	Medium	Unlikely	Low risk	No Asbestos found within tested soils.
Ground Gases	Future Site Users;	Inhalation	Medium	Low likelihood	Moderate/ Low risk	Characteristic Situation 2 - Low risk classification
	Construction workers.	Inhalation	Medium	Unlikely	Very Low risk	
Radon	Future Site Users;	Inhalation	Medium	Unlikely	Low risk	The site is not in a Radon affected area so no radon protective measures are required in any developments.

8.10 Contamination Risk Summary and Mitigation

The following principal contamination risks have been determined following the recent site investigation works:

Risks to Human Health

- Contamination in shallow made ground found to be limited to isolated exceedance of lead, when assessed against generic assessment criteria for residential development (with gardens).
- Minor elevated PAH species were indicated above assessment criteria in one sample.
- No asbestos encountered in any of samples testes.

In areas where the made ground is to be left in place, such as in the area of the bungalows in TP5, to prevent human contact with the site soils in any garden or soft landscaped areas, either the material should be excavated out or a capping later will need to be installed.

A capping layer will likely comprise a minimum 400mm of topsoil/subsoil, with geofabric separation layer at the base to prevent mixing with site soils. A photographic record of the installation of any clean cap, along with the soils testing and subsequent proof that the system has been installed as agreed will be incorporated into a verification report.

A watching brief should be maintained during the site strip and subsequent earthworks in order to identify any unforeseen contamination.

To protect against risks of short term contact with site soils, site construction workers will need to ensure an appropriate level of PPE is provided. Good hygiene and site management practices will be required (i.e provision of hand washing and welfare facilities, tool box talks etc).

A suitable strategy for dealing with unexpected contamination will be employed, along with watch brief by a contamination specialist as outlined above.

Given the sloping nature of the site temporary works should be carried out in good practice with relevant control measures in place to control silt and surface water run-off.

9 GEOTECHNICAL ASSESSMENT

9.1 Introduction

It is understood that a residential development is proposed, comprising single and two storey buildings. No proposed structural loads have been given but it is likely that the proposed buildings will comprise lightly loaded structures.

Up to 3m of excavation is likely required in parts of the site where the southern buildings are to be cut into the hillside to create a level plot. To support the proposed excavation a 3m high retaining wall is proposed along the centre of the site. Below is a schematic cross section through the site, showing areas of proposed excavation to form the lower levelled area as well as areas of up filling to form level ground levels for upslope property's.

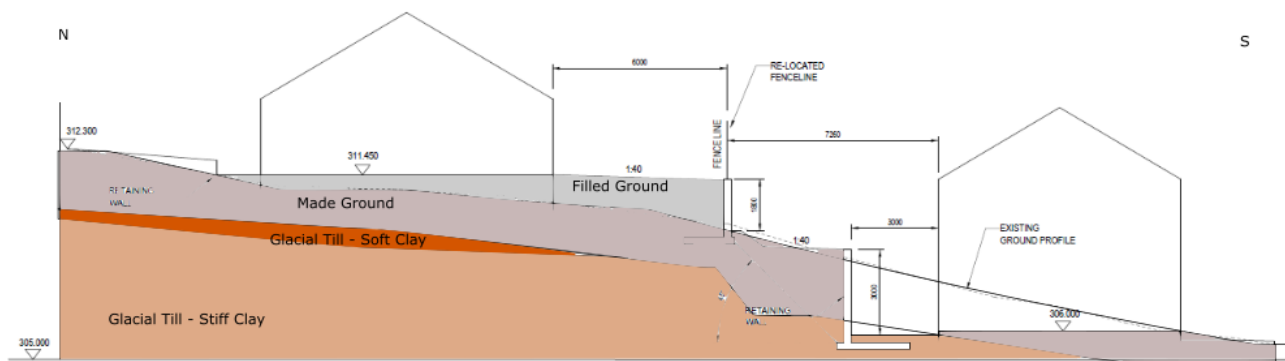


Figure 4: Schematic Cross Section of Proposed Buildings

9.2 Excavations

Based on the proposed retaining wall layout and site sections (Project Ref: 18219, Dwg No. Sk1, Rev P2, dated 11.7.18), excavations of up to 3m are expected to take place over the central area of the site to lower the site levels to the finished floor level of 306.0mAOD. Based on the schematic cross section shown in figure 4, the bulk of the excavations will take place through the made ground with some excavation within the upper layer of glacial till.

The main problems envisaged will be the presence of large boulders within both the fill and glacial till. The boulders contained within the ground are likely to have fractured along pre-existing discontinuity surfaces during transport and deposition, they are likely to be less fractured and more difficult to break than the bedrock from which they were derived. The boulder exposed during the ground investigation included very strong sub-rounded limestone, so larger excavation plant with toothed buckets (no less than 12T) are likely to be required to carry out the excavations. Provision should be made to remove numerous boulders from excavations which will likely need to be removed from site, so any contractors should be made aware of their presence at the tender stage. Buried foundations and possible basement structures are also likely to be encountered from the historical residential buildings that once covered the site.

Temporary excavations are likely to be stable in the short term, if the sides are battered back at an angle of 1:2 (26°), although this is likely to be greatly reduced if water bearing pockets or lenses of granular soils which could affect slope performance are encountered. The CIRIA report C504 Engineering in Glacial Tills, provides guidance for preliminary design, and suggests permanent cuttings through glacial till of height no greater than 2.5m should be stable if cut an angle of no more than 1:1.75 (30°) and if between 2.5m to 5.0m in height then should not be no greater than 1:3.5 (16°).

If there is insufficient space available on site to batter back excavations, then a suitable shoring system should be designed and implemented to support the sides of any excavations.

Groundwater was only noted in TP5 and occurred at the base of the made ground, all standpipes recorded groundwater within them, which indicates that there is likely to be seepages within the made ground and within the more granular pockets of till. Any groundwater ingress should be readily controlled by sump and pump techniques in accordance with CIRIA Report C750 Groundwater Control – design and practice, with any discharge consents in place prior to commencement of works.

Given the thickness of made ground, all excavations or below ground voids, should be checked for the presence of harmful gases and vapours prior to the entry of any personnel.

9.3 Foundation Options

Foundations should extend through any made ground and into the underlying natural glacial till deposits. After excavation this will likely be exposed at subgrade level over the southern area of the site. Based on NHBC guidelines a minimum foundation depth of 0.75m should be used to prevent any shrink/swell movements, which should be extended over the western side of the site, where there are existing trees which will be removed, in accordance to NHBC guidelines depending of proximity of roots to proposed footings. Using a characteristic undrained shear strength of 80kPa an allowable bearing capacity in the order of 180kPa will be available founding in the glacial clay of at least stiff strength.

Over the north western corner of the site there is a layer of soft clay situated beneath the made ground, and the foundation should extend through this into the underlying stiff clay encountered at a depth of 2.1m, where an allowable bearing pressure in the order of 200kPa is available.

If this depth is deemed to be not viable, then a raft foundation can be used founding on the soft clay, where an allowable bearing pressure of no more than 40kPa will limit settlement to less than 50mm. The made ground in this area has slightly elevated sulphate levels so any concrete should be designed with a design sulphate class DS-2 and AC-2 classification. The raft should be designed to withstand differential settlement.

If the foundations are to be placed into the made ground, then the fill should be sufficiently improved by compaction techniques so that deformations are acceptably small or that the foundations and structures are sufficiently flexible to tolerate large deformations in the fill.

9.4 Floor Slabs

Given the that made ground across the site is greater than 0.6m in thickness, and even in the areas where the made ground is removed to expose the cohesive glacial till, suspended floor slabs are recommended across the site, due to the possibility of uneven ground movements across the site.

9.5 Retaining Walls

A retaining wall will be required to retain the soil where excavation into the site has taken place. The retained material will mainly comprise made ground and some glacial till. The type of retaining wall has not been decided but the options include gravity walls comprising either a cantilever or crib wall.

Based on Eurocode 7 the Design Approach 1 should be checked so that the design satisfies both Combination 1 and Combination 2 partial factors. A material factor (M2) of 1.25 should be used for the angle of shearing resistance, therefore the characteristic values noted in Section 7 for the made ground will become 26°, and 23° for the glacial till. These can then be used to calculate the active earth pressure coefficients (K_a).

All surcharge loads such as a sloping backfill, footing loads, passive pressures from higher walls where retaining walls are terraced, stockpiled material, construction traffic loads etc should be added to the above pressures.

The retaining wall should be founded within the stiff to very stiff glacial till clays and should be designed in accordance with Eurocode 7 and BS 8002:2015.

9.6 Protection of Buried Concrete

The site has been assessed for the potential for chemical attack on buried concrete, using the BRE Special Digest 1 (2005) guidance. The assessment has been carried out separately for the made ground and for the glacial till deposits. The results of the testing are summarised in the table below.

Hole ID	Depth	Total Sulphur (%)	Total Sulphate (%)	Total Potential Sulphate (%)	Water Soluble Sulphate (mg/l)	Oxidizable Sulphides (%)	pH
Made Ground							
TP5	0.6	0.24	0.33	0.72	0.33	0.39	7.9
TP2	0.6		0.022		0.022		8.1
TP4	0.3		0.18		0.18		8.1
WS1	0.5		0.022		0.022		8.3
WS2	1.1		0.025		0.025		8.1
WS5	0.6		0.019		0.019		8.1
Glacial Till							
TP2	1.8	0.03	0.035	0.09	0.035	0.055	8.5
TP5	1.5	0.013	0.022	0.039	0.022	0.017	8.1
WS3	3.0	0.011	0.02	0.033	0.02	0.013	8.4

Table 16: Sulphate Tests Summary

The characteristic values for each stratum was taken to be the highest values. Based on table C2 of the BRE guidance, all concrete placed within the natural strata will have a Design Sulphate (DS) of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) class AC-1s, based on the groundwater being static and AC-1 below the groundwater table. The sulphate results from the made ground in TP5 at 0.6m has an oxidizable sulphide of over 0.3% which indicates pyrite may be present within this sample, so as some groundwater was noted in this area.

9.7 Earthworks

It is understood that a small amount of earthworks will be required to raise site levels over the northern end of the site. The made ground and the glacial till encountered on site can generally be re-used as an engineered fill providing that all boulders and cobble size particles are removed from the material prior to placement. In the area of TP5 the made ground has been classed as Hazardous so this will not be able to be re-used and will require removal from site. The soft clays encountered beneath the made ground in TP5 is also not suitable for re-use unless all organic and deleterious material is removed prior to placement.

Based on the particle size distribution tests that have been carried out, both the samples from the made ground and the glacial till will be classed as 2A&2B cohesive general fill.

Based on the moisture content and plastic limit two of the natural samples in the north western area (TP5 & WS5) and one in the made ground of TP1 will be classed as 2A Wet Cohesive, with all the other samples tested classed as 2B dry cohesive material.

A single compaction test using a 2.5kg mould was undertaken on one sample from the glacial till.

Exploratory Hole No.	Depth	Natural Moisture Content (%)	Optimum Moisture Content	Max Dry Density (Mg/m ³)	Degree of Compaction at Natural MC (%)
TP3	1.5	12	12	1.97	100

Table 17: Compaction Testing

Based on the above, the glacial till and made ground are of similar properties and can be placed and compacted to 100% of its standard maximum dry density at the existing moisture content, so no or limited moisture conditioning will be required. We note that the investigation was carried out in the summer months, so if carried out in the winter then the moisture content of the material will likely increase so may require drying out.

9.8 Soakaway Design

No soakaway testing has been carried out but given the cohesive nature of both the made ground and the underlying glacial till, then soakaways will not be suitable for the site.

9.9 Underground Workings

No underground workings were found during the site works, with ironstone only recorded in one borehole at a depth of around 26m below ground level which was approximately 10m below the rockhead level. Figure 5 below shows a schematic section of the geology encountered with the extent of the ironstone layer being inferred.

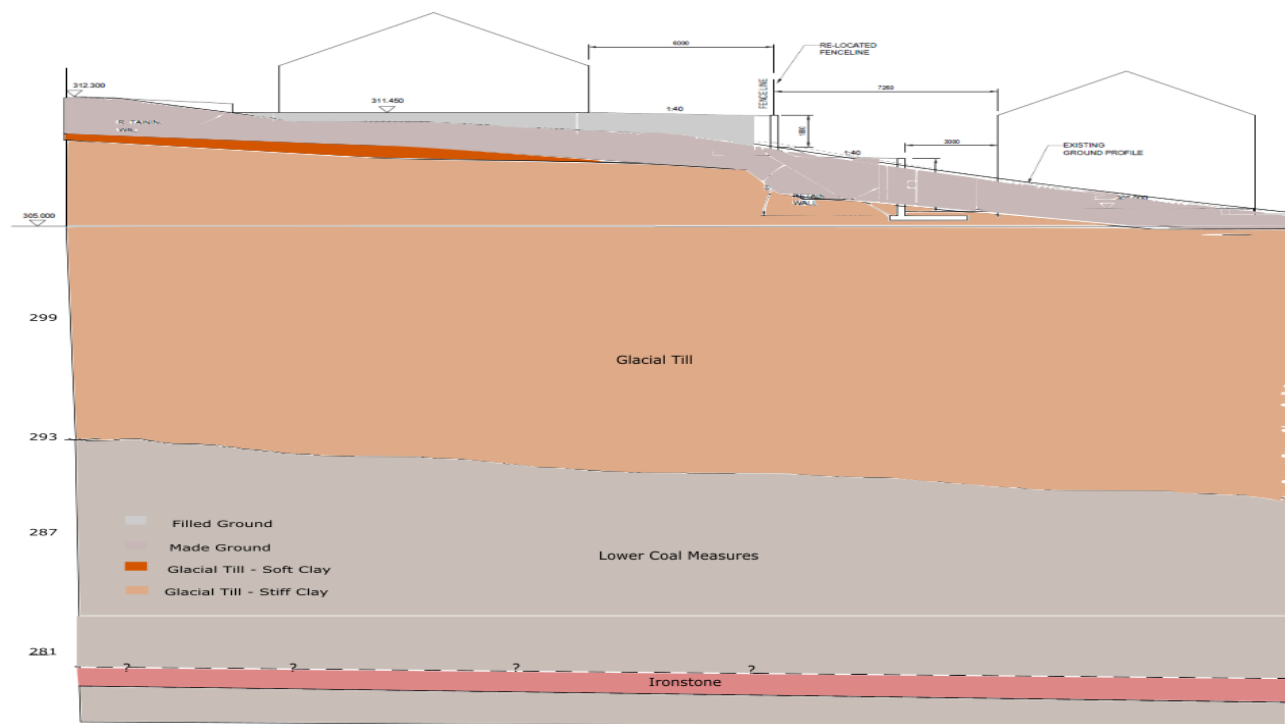


Figure 5: Schematic Geological Section

Given that no voids or disturbed ground were encountered within the boreholes, and the fact that ironstone was encountered to still be present beneath the site, then the likelihood that there are underground workings at shallow depth are extremely low. This coupled with the fact that ironstone in the area was worked at crop from shallow mines, so to get to the crop, then at least 15m of glacial till and then another 10m of bedrock would have had to be excavated, which given the nature of the glacial till and strength of bedrock again seems extremely unlikely.

Based on the above evidence and the fact the earliest map from 1875, shows the entire site to be covered by terraced property's, it is concluded that the risk posed by underground ironstone workings would be very low.

10 GEOTECHNICAL RISK REGISTER

A Geotechnical Risk Register is a method of identifying hazards which may arise during the construction phase of works based on the data currently obtained for the site. The register is a work in progress and as further information arises, it should be updated in order to quantify the risk. At this stage, the aspects covered by the register are attributed to Cost and Health and Safety, although as site works commence, programme may become a prominent factor.

The register is based on a matrix similar to the conceptual site model (CSM) for contamination in the sections above. The main constituents of the register are the Identified Hazard, Preconditioning and Consequence. They will govern the likelihood of the event occurring and impact resulting for event occurrence which are rated 1-5 with 1 being Very low and 5 being Very High. These will be multiplied together in order to inform a risk rating for each of the identified hazards.

Risk Rating (R) = Probability (P) x Impact (I)

Table 18: Risk Rating

Risk Rating	P x I
Severe	20-25
High	15-16
Moderate	9-12
Low	6-9
Negligible	1-4

		I	I	I	I	I
		5	4	3	2	1
P	5	25	20	15	10	5
P	4	20	16	12	8	4
P	3	15	12	9	6	3
P	2	10	8	6	4	2
P	1	5	4	3	2	1

Plate 5: Risk Matrix

Table 19: Geotechnical Risk Register

Category	Hazard	Trigger	Consequence	Risk Rating			Remedial Action	Risk Rating		
				P	I	R		P	I	R
Excavations & Earthworks	Collapse/Instability	1. Excessive Groundwater/ Rainfall 2. Soft Ground Conditions 3. Cuttings too steep/insufficient support	1. Damage to Plant and Equipment 2. Death or Serious Injury	2	5	10	Review ground investigation report for specific locality excavated. Provide briefing and method of safe working practice Ensure pumping and slope support equipment are readily available Temporary 1:2 batter slopes in clay. Appropriate designed retention systems.	1	5	5
	Surface Water flooding of excavations	1. Excessive Rainfall event 2. Prolonged periods of steady rainfall	1. Collapse/ instability of excavations 2. Delays to Programme 3. Unsuitable Materials	3	5	15	Forecast to be checked a week in advance and changes to works made to suit. Seasonal working Provision of pumping equipment	3	3	9
	Quality and compaction of imported fill soils	1. Cost implications mean that poor quality fill is imported	1. Settlement within fill 2. Longer programme to ensure fill meets	3	4	12	Material management plan to be implemented	2	3	6

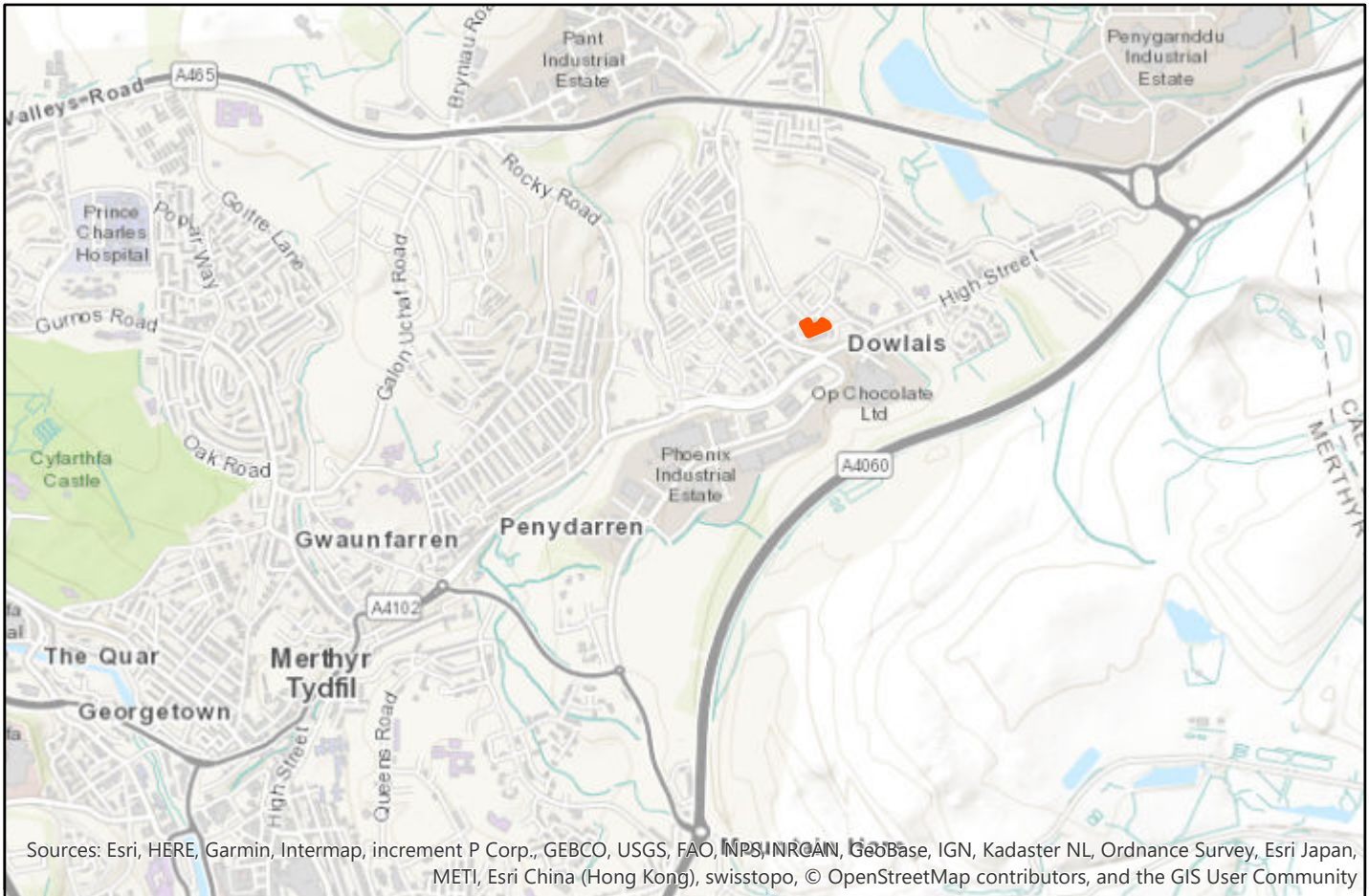
Category	Hazard	Trigger	Consequence	Risk Rating			Remedial Action	Risk Rating		
				P	I	R		P	I	R
		2. Programme inhibits appropriate compaction techniques to be implemented	requirements (testing and verification) 3. Maintenance of structures constructed on poor fill				Fill to be in line with recommendations made by the materials management plan Fill to be sourced from verified donor site and vendors			
	Obstructions in ground	1. Difficulties in excavating ground 2. Boulders likely in made ground and glacial till. 3. Historical foundations and basements may be present.	1. Time delays, increase cost.	5	3	15	Large excavators required, tenders should include provisions to overcome this.	5	1	5
Contamination	Surface Soils	1. Slightly elevated Contamination in site soils	1. Human Health Issues 2. Increased Disposal Costs	5	3	15	PPE for workers. Clean cover in gardens.	1	3	5
	Aggressive Chemicals (Sulphates)	1. Sulphate Levels	1. Degradation of concrete used in the ground 2. Failure of foundations to meet required standards	3	4	12	Use identified classes for all concrete used in ground Check ground investigation report	1	5	5
	Ground Gases	1. Build-up of ground gasses in excavations and sub floor voids from made ground.	1. Risk of explosion	3	5	15	Check ground gas section of geotechnical report and apply appropriate measures.	1	5	5
	Silt Run Off	1. Excessive rainfall	1. Silt run off into adjacent roadway and drains	5	3	15	Silt control measures should be in place on site around perimeter of site..	3	1	3

Category	Hazard	Trigger	Consequence	Risk Rating			Remedial Action	Risk Rating		
				P	I	R		P	I	R
Foundations	Ultimate limit state failure (Bearing Capacity)	1. Unknown loadings 2. Degradation of concrete 3. Insufficient depth of foundations	1. Building collapse/ need to rebuild	2	5	10	Appropriate geotechnical design	1	5	5
	Serviceability limit state failure (settlement)	1. Soft clays in NW area 2. Variable thickness and strength of made ground.	1. Cracking/deformation of slab	4	5	20	Foundations should extend through these layers or adopt a raft slab capable of withstanding settlement.	2	5	10
	Obstructions within made ground	1. Large boulder and cobbles within made ground glacial till.	1 Slow excavation. 2 Increased costs for disposal and earthworks	5	3	15	Provisions should be made beforehand on how to deal with boulders and obstructions in ground. Inspect exploratory hole logs.	5	1	5
	Underground Ironstone Workings	1. Potential collapse of ground above historical workings	1 Sink hole formation 2 Possible building collapse	3	5	15	Drilling carried out and no evidence of workings found.	1	3	3

11 References

- BS EN 14688 – 2 (2004) + A1 (2013) Geotechnical investigation and testing. Identification and classification of soil. Principals for a classification.*
- BS EN 14689 – 1 (2003) Geotechnical investigation and testing. Identification and classification of rock. Identification and description.*
- BS EN 14688 – 1 (2002)+ A1 (2013) Geotechnical investigation and testing. Identification and classification of soil. Identification and description.*
- BS EN. (2007). *1997-1 Eurocode 7 Geotechnical design – Part 1 General rules*. BSI Standards Limited.
- BS EN. (2007). *1997-2 Eurocode 7 - Geotechnical Design - Part 2: Ground Investigation and testing*. BSI Standard Ltd.
- BSI. (2015). *BS5930 Code of Practice for Ground Investigations*.
- BSI. (2015). *BS8004 Code of Practice for Foundations*.
- Carter, M, and Bentley, S, P. (1991). *Correlations of soil properties*. Michigan: Pentech.
- Chandler, R. J. (1969). The effect of weathering on the shear strength properties of Keuper Marl. *Geotechnique*, 19, 321-334.
- Chandler, R. J. (1973). *Further work on the engineering properties of Keuper Marl*. Construction Industry Research and Information Association Report, No. 49.
- CIRIA Report 156 - Infiltration drainage - Manual of good practice*. (1996). CIRIA.
- Hobbs, P. R. (2002). *Engineering geology of British rock and soils - Mudstones of the Mercia Mudstone Group*. British Geology Survey Research Report.
- Leach, B. A. (1979). The design and performance of large diameter bored piles in weak mudstone rocks. *Proceedings of the 7th European Conference of Soil mechanics and Foundation Engineering* 3, (pp. 101-108). Brighton.
- NA to BS EN. (n.d.). *1997-1:2004 UK National Annex to Eurocode 7: Geotechnical design - Part 1: General Rules*. BSI Standards Limited.
- NA to BS EN. (n.d.). *1997-2:2004 UK National Annex to Eurocode 7: Geotechnical design - Part 2: Ground investigation and testing*. BSI Standards Limited.
- Stroud, M. A. (1975). *The standard penetration test and the engineering properties of glacial materials*. Birgminham: Proceedings of the symposium of glacial materials.

APPENDIX A: SITE LOCATION PLAN

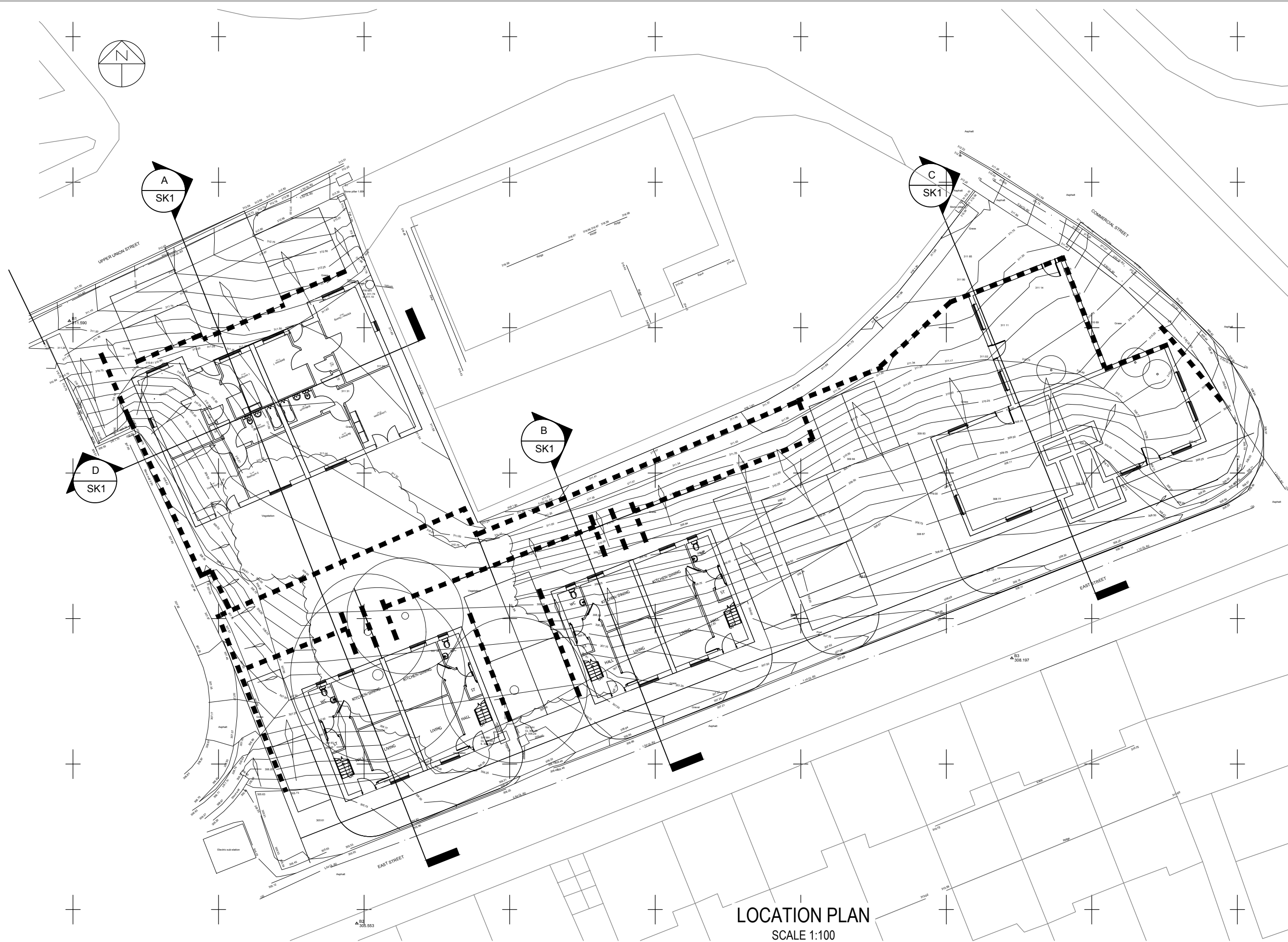


Appendix 1: Site Location Plan

East Street, MerthyrTydfil

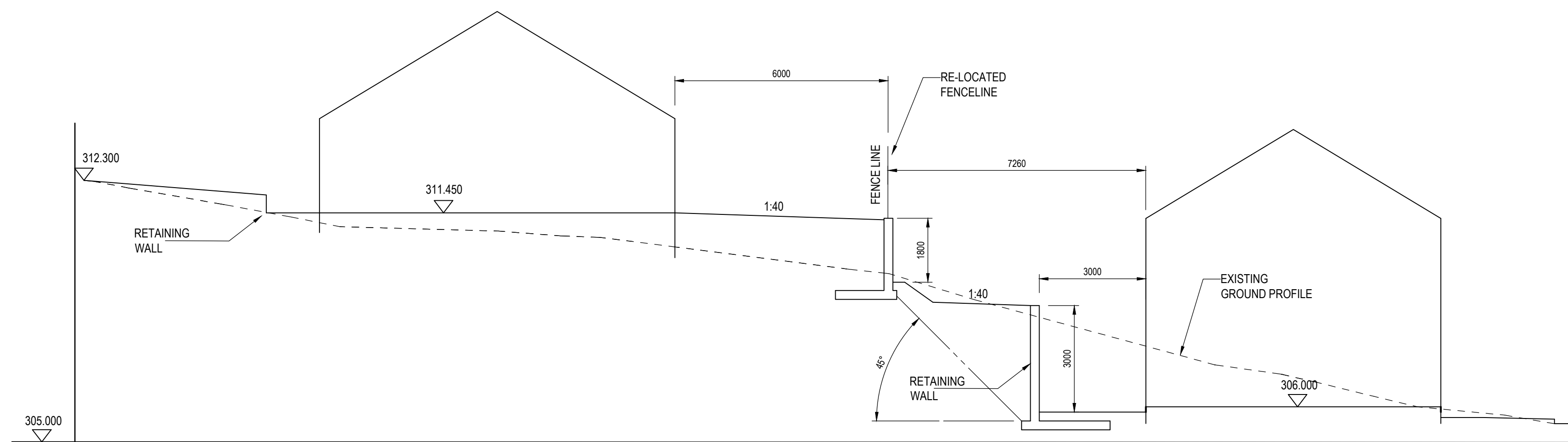


APPENDIX B: PROPOSED SITE DEVELOPMENT PLAN

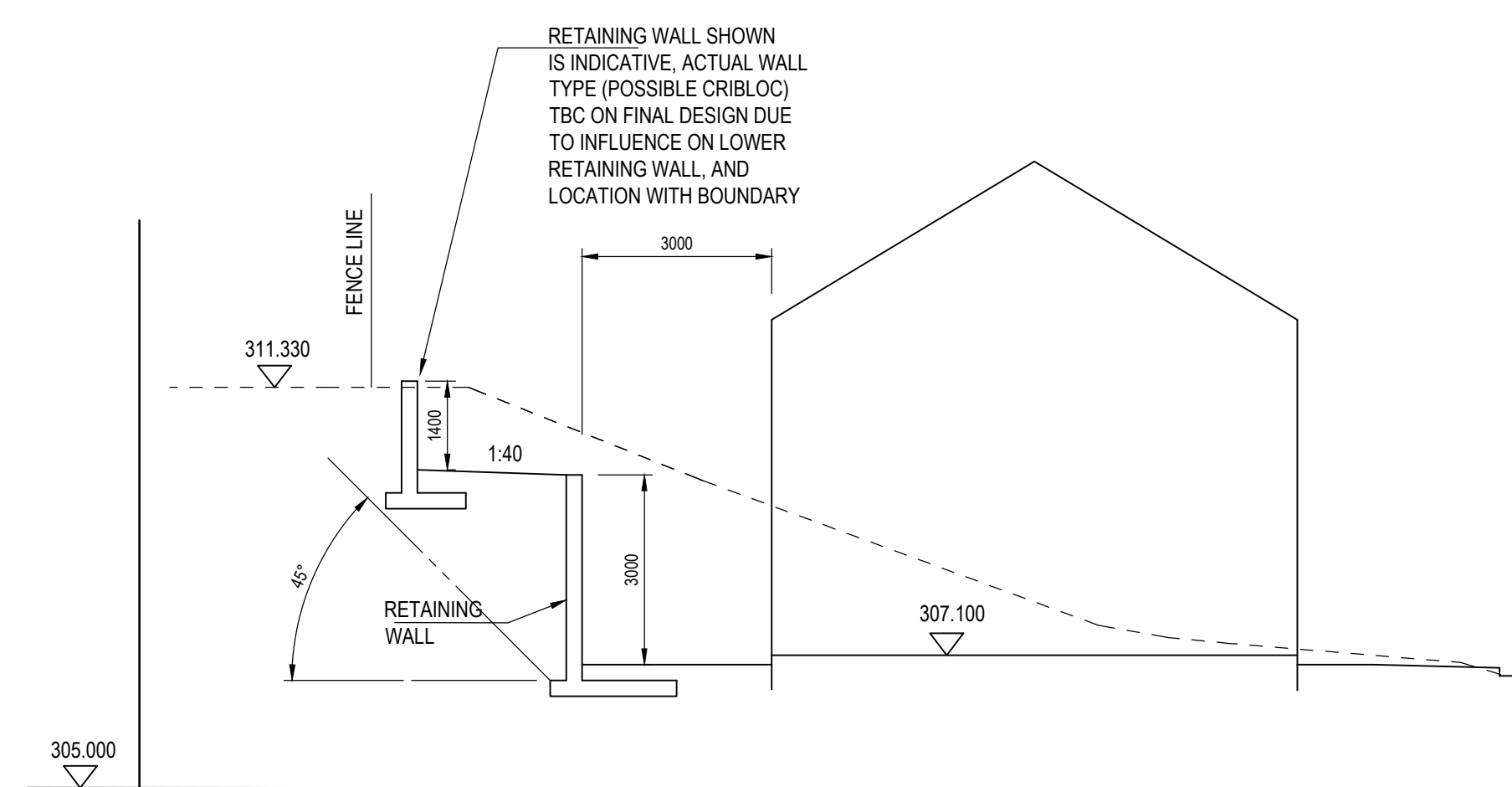


KEY

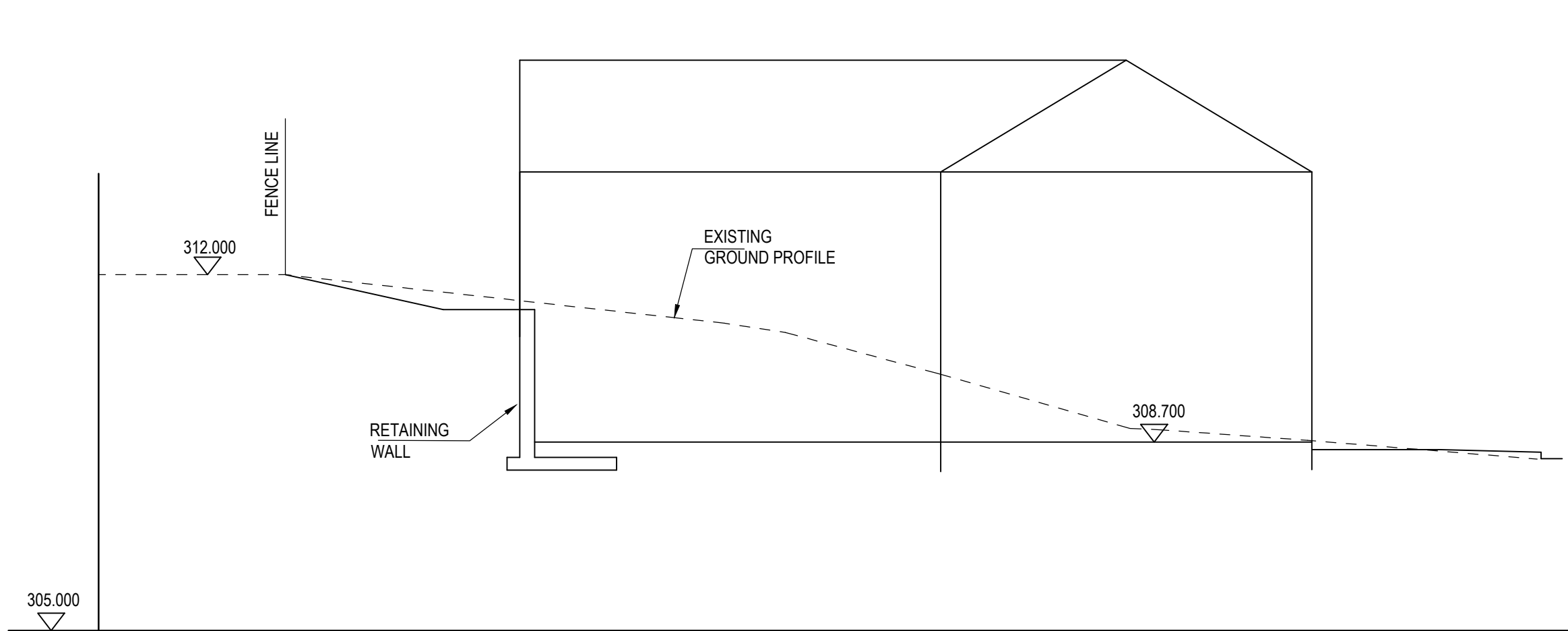
----- PROPOSED RETAINING WALLS



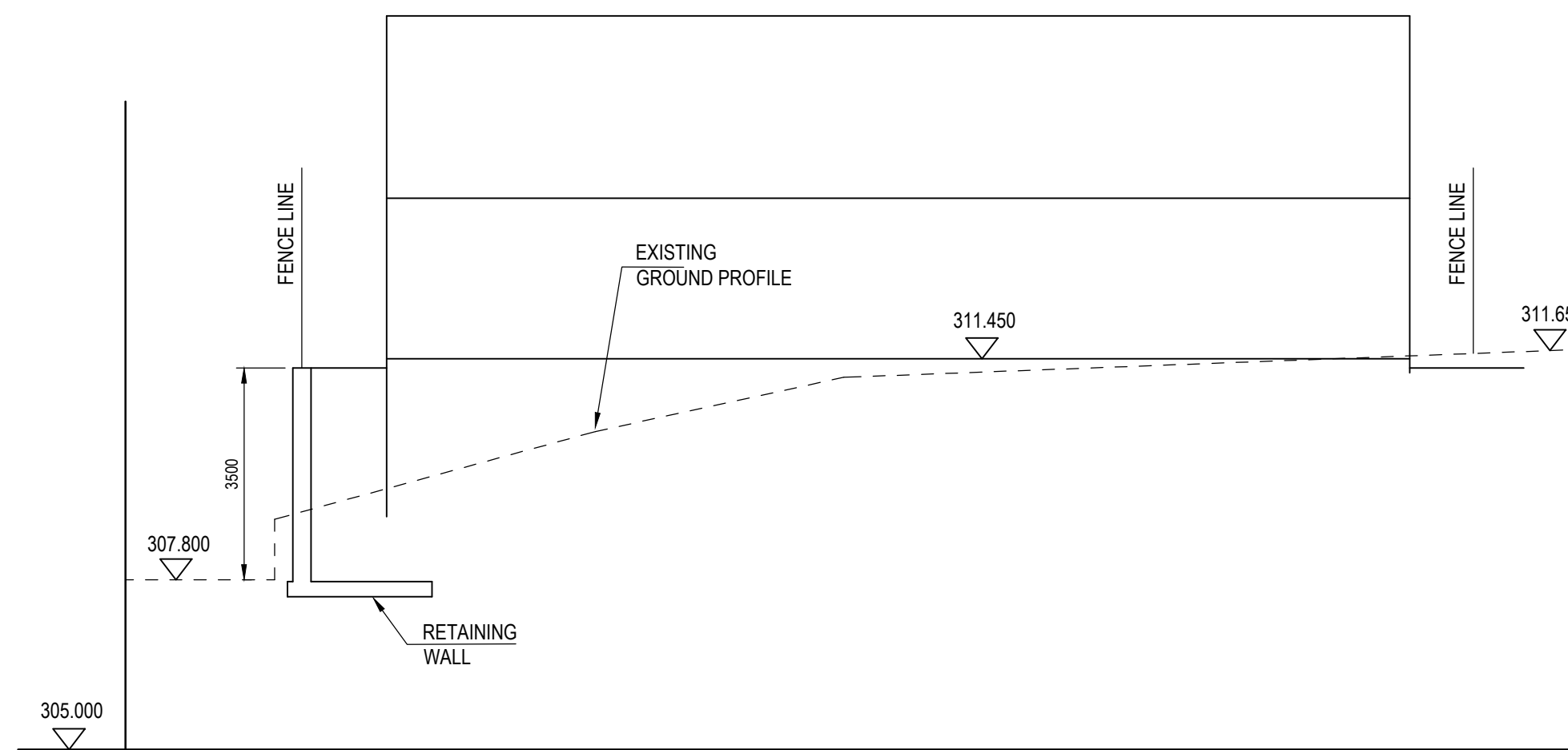
SECTION A
SCALE 1:100



SECTION B
SCALE 1:100



SECTION C
SCALE 1:100



SECTION D
SCALE 1:100

P1	11.07.2018	UPDATED TO SUIT COMMENTS	SM	MPT
P1	11.07.2018	PRELIMINARY ISSUE	SM	MPT
Rev	Date	Description	By	Apvd

PROJECT:
EAST STREET MERTHYR TYDFIL

TITLE:
PROPOSED RETAINING WALL LAYOUT
AND SITE SECTIONS

CLIENT:
MERTHYR HOUSING

SCALE@A1:
1:250, 1:100

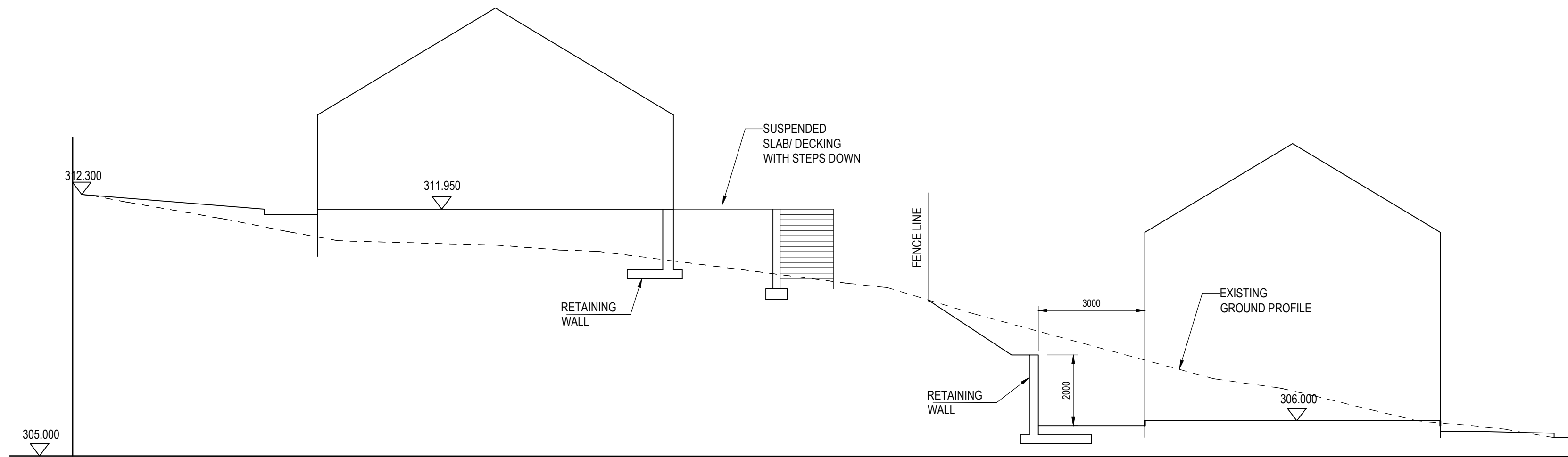
PROJECT REF:
18219
DRAWING No:
SK1
REV:
P2

Revision Referencing
P = Preliminary A = Approval T = Tender C = Construction

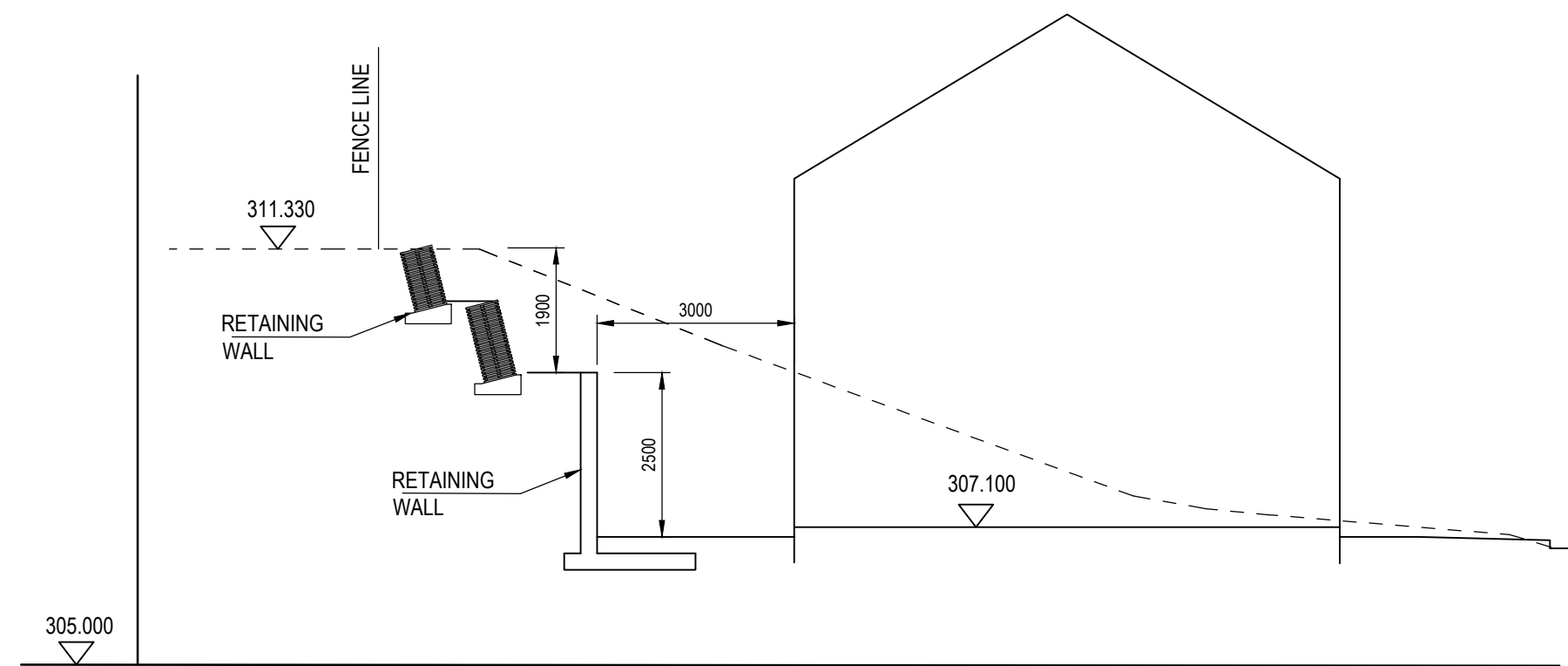
Jubb



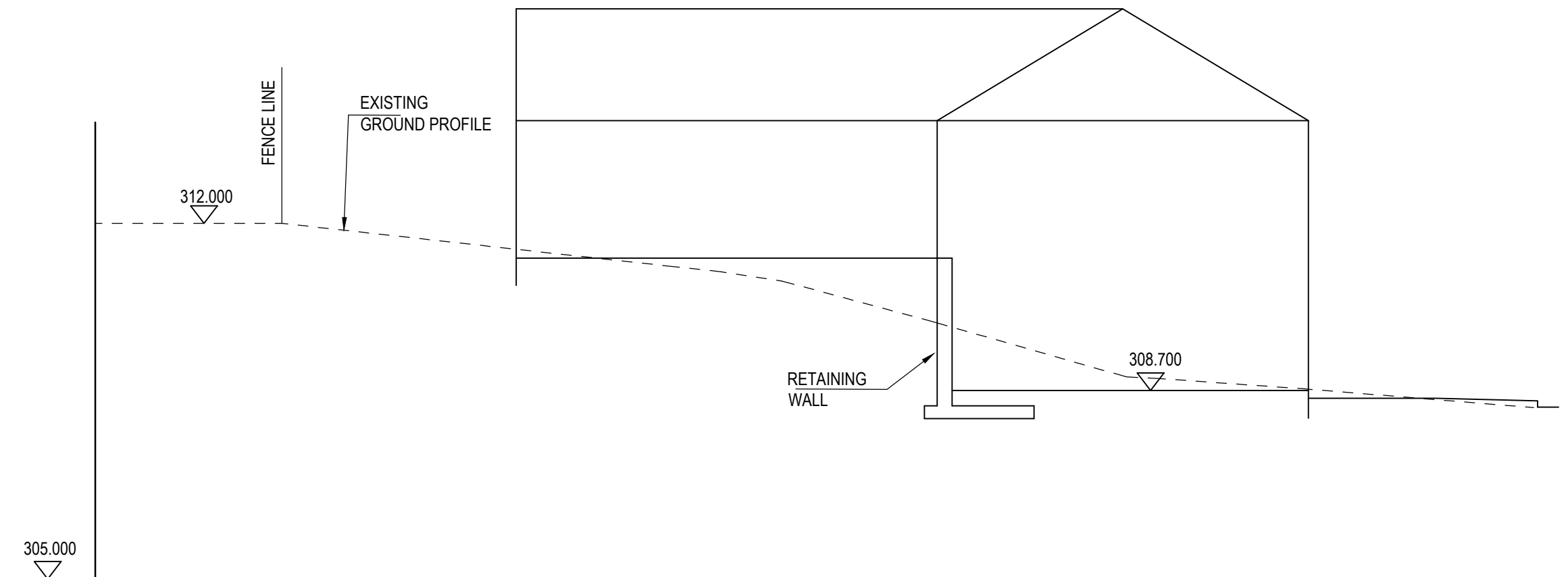
PROPOSED RETAINING WALLS



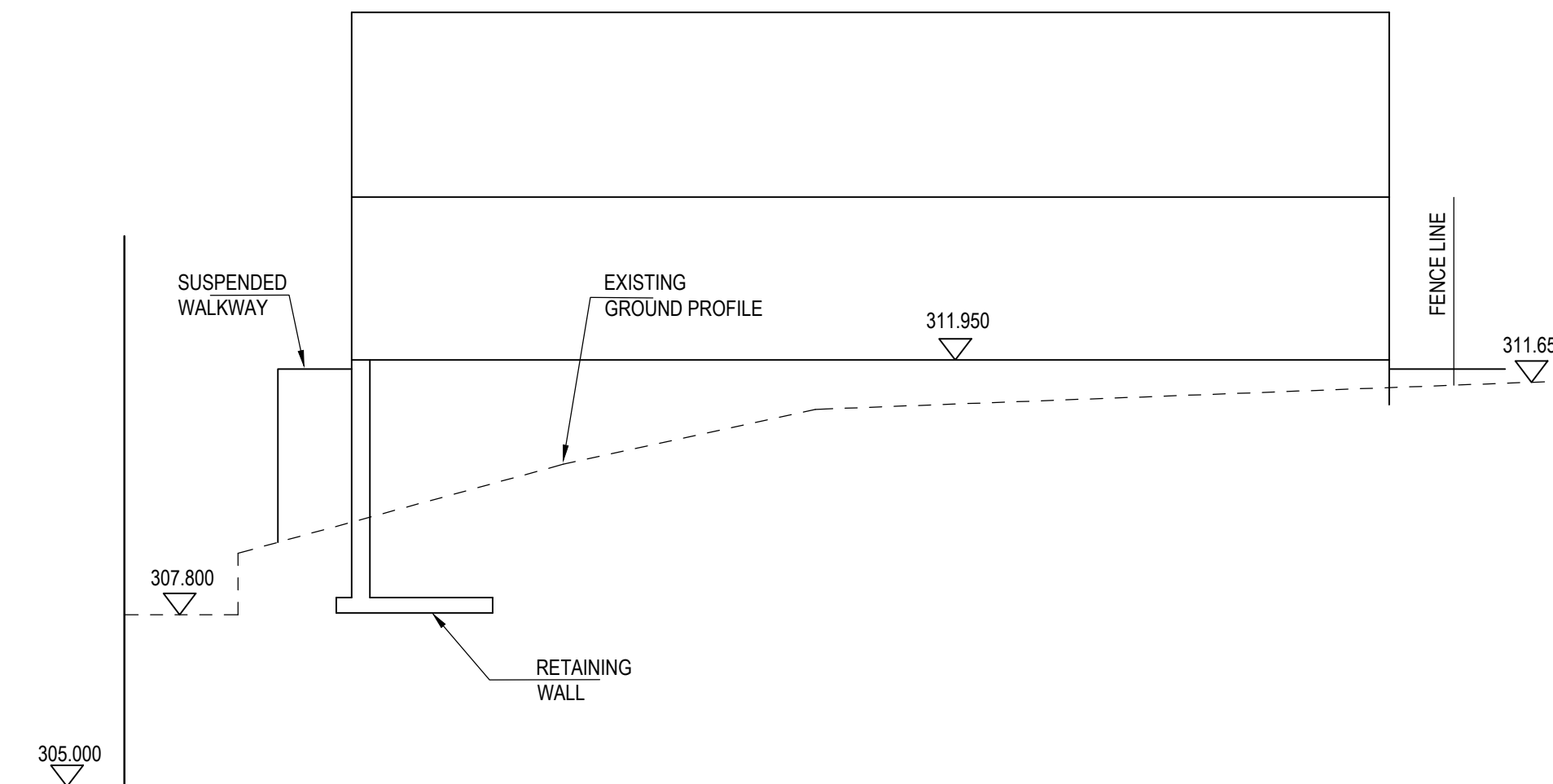
SECTION A
SCALE 1:100



SECTION B
SCALE 1:100



SECTION C
SCALE 1:100



SECTION D
SCALE 1:100

P1	11.07.2018	PRELIMINARY ISSUE	SM	MPT
Rev	Date	Description	By	Apvd

PROJECT:
EAST STREET MERTHYR TYDFIL

TITLE:
PROPOSED RETAINING WALL LAYOUT
AND SITE SECTIONS

CLIENT:
MERTHYR HOUSING

SCALE@A1:
1:250, 1:100

PROJECT REF:
18219

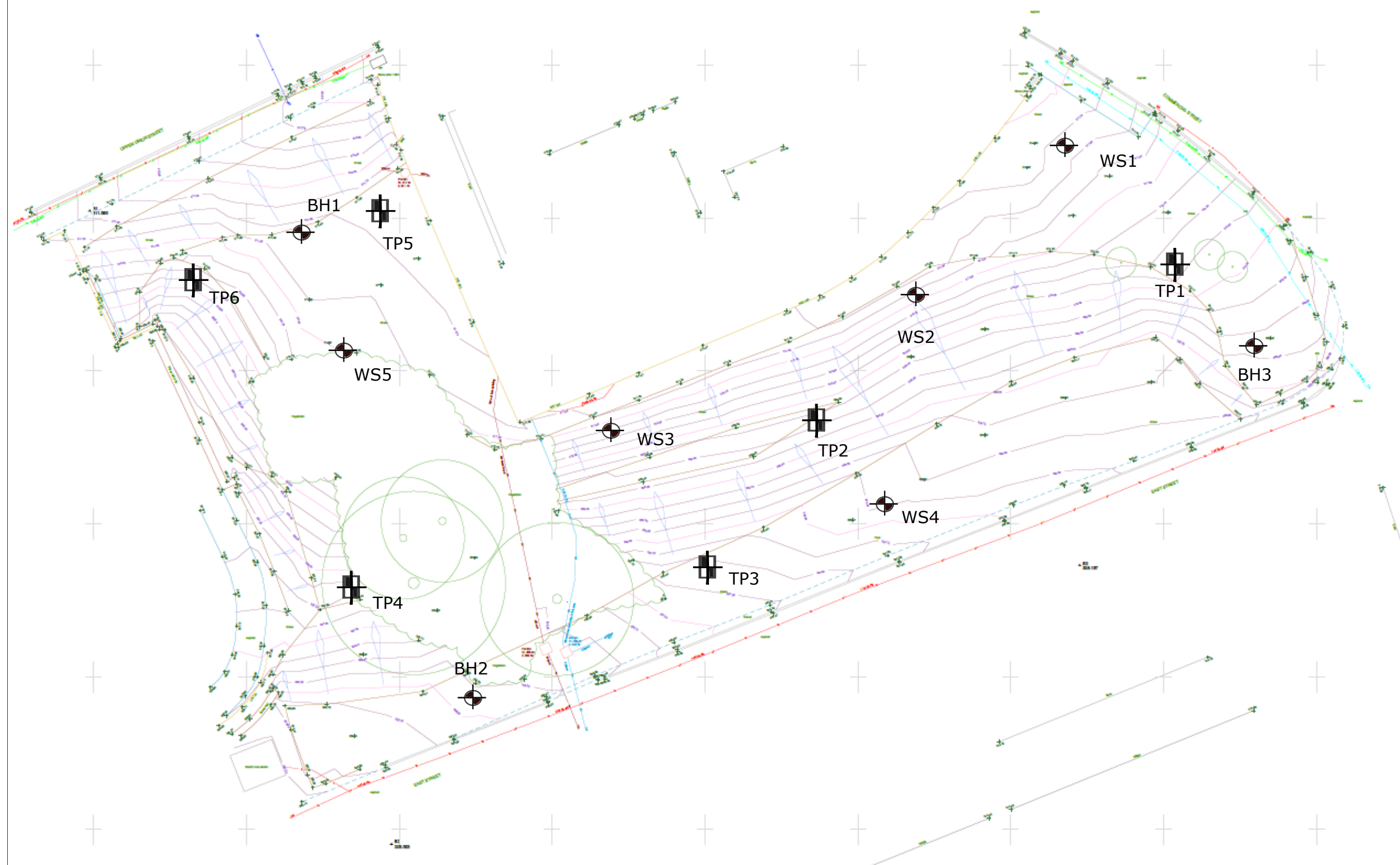
DRAWING No:
SK1

REV:
P1

Revision Referencing
P = Preliminary A = Approval T = Tender C = Construction

Jubb

APPENDIX C – EXPLORATORY HOLE LOCATION PLAN

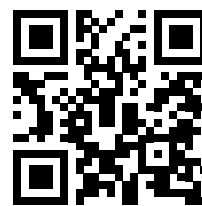


P1		
Rev	Date	Description By Apvd
PROJECT:		
East Street, Merthyr Tydfil		
TITLE:		
Exploration Hole Location Plan		
CLIENT:		
Merthyr Tydfil Housing Association		
SCALE@A1:		
PROJECT REF: 18219		
DRAWING No:		REV:
Revision Referencing		
P = Preliminary A = Approval T = Tender C = Construction		

Jubb

APPENDIX D: HAZWASTE WASTE CLASSIFICATION REPORT

Waste Classification Report



HXVQR-FU7MS-EHM24

Job name

East Street, Merthyr Tydfil

Description/Comments

Project

Site

Waste Stream Template

Waste Stream Template for Contaminated Soils

Classified by

Name:

Ian Squibbs

Date:

26 Sep 2018 15:53 GMT

Telephone:

07919 522 985

Company:

Jubb Consulting Engineers Ltd

Suite B, Ground Floor West

St James Court, St James Parade

Bristol

BS1 3LH

Report

Created by: Ian Squibbs

Created date: 26 Sep 2018 15:53 GMT

Job summary

#	Sample Name	Depth [m]	Classification Result	Hazard properties	Page
1	TP2	0.60	Non Hazardous	HP 7	2
2	TP4	0.30	Non Hazardous		4
3	TP5	0.60	Hazardous		6
4	WS1	0.50	Non Hazardous		8
5	WS2	1.10	Non Hazardous		10
6	WS5	0.60	Non Hazardous		12

Appendices

	Page
Appendix A: Classifier defined and non CLP determinands	14
Appendix B: Rationale for selection of metal species	15
Appendix C: Version	15

Classification of sample: TP2

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	TP2	LoW Code:	Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	0.60 m	Entry:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)	
Moisture content:	16%			
	(no correction)			

Hazard properties

None identified

Determinands

Moisture content: 16% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number									
1	arsenic { arsenic trioxide }				11	mg/kg	1.32	14.524	mg/kg	0.00145 %		
	033-003-00-0	215-481-4	1327-53-3									
2	cadmium { cadmium sulfide }			1	0.16	mg/kg	1.285	0.206	mg/kg	0.000016 %		
	048-010-00-4	215-147-8	1306-23-6									
3	chromium in chromium(III) compounds { chromium(III) oxide }				17	mg/kg	1.462	24.846	mg/kg	0.00248 %		
		215-160-9	1308-38-9									
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<0.5	mg/kg	1.923	<0.962	mg/kg	<0.0000962 %		<LOD
	024-001-00-0	215-607-8	1333-82-0									
5	copper { copper sulphate pentahydrate }				25	mg/kg	3.929	98.226	mg/kg	0.00982 %		
	029-023-00-4	231-847-6	7758-99-8									
6	lead { lead chromate }			1	42	mg/kg	1.56	65.512	mg/kg	0.0042 %		
	082-004-00-2	231-846-0	7758-97-6									
7	mercury { mercury dichloride }				0.31	mg/kg	1.353	0.42	mg/kg	0.000042 %		
	080-010-00-X	231-299-8	7487-94-7									
8	nickel { nickel chromate }				26	mg/kg	2.976	77.383	mg/kg	0.00774 %		
	028-035-00-7	238-766-5	14721-18-7									
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				0.33	mg/kg	2.554	0.843	mg/kg	0.0000843 %		
	034-002-00-8											
10	zinc { zinc chromate }				79	mg/kg	2.774	219.158	mg/kg	0.0219 %		
	024-007-00-3											
11	naphthalene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
	601-052-00-2	202-049-5	91-20-3									
12	acenaphthylene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		205-917-1	208-96-8									
13	acenaphthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		201-469-6	83-32-9									
14	fluorene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		201-695-5	86-73-7									

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number							
15	phenanthrene	201-581-5	85-01-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
16	anthracene	204-371-1	120-12-7		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
17	fluoranthene	205-912-4	206-44-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
18	pyrene	204-927-3	129-00-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
19	benzo[a]anthracene	601-033-00-9	200-280-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
20	chrysene	601-048-00-0	205-923-4		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
21	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
22	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
23	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
24	benzo[ghi]perylene	205-883-8	191-24-2		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
26	TPH (C6 to C40) petroleum group		TPH		<10 mg/kg		<10 mg/kg	<0.001 %		<LOD
27	confirm TPH has NOT arisen from diesel or petrol				☒					
Total:								0.049 %		

Key

- User supplied data
- Determinand values ignored for classification, see column 'Conc. Not Used' for reason
- Determinand defined or amended by HazWasteOnline (see Appendix A)
- Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
- <LOD Below limit of detection
- CLP: Note 1 Only the metal concentration has been used for classification

Classification of sample: TP4

✔ **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	TP4	LoW Code:	Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	0.30 m	Entry:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)	
Moisture content:	12% (no correction)			

Hazard properties

None identified

Determinands

Moisture content: 12% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number									
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3	1	26 mg/kg	1.32	34.328 mg/kg	0.00343 %			
2	cadmium { cadmium sulfide }	048-010-00-4	215-147-8	1306-23-6		0.29 mg/kg	1.285	0.373 mg/kg	0.000029 %			
3	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		18 mg/kg	1.462	26.308 mg/kg	0.00263 %			
4	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<0.5 mg/kg	1.923	<0.962 mg/kg	<0.0000962 %			<LOD
5	copper { copper sulphate pentahydrate }	029-023-00-4	231-847-6	7758-99-8		180 mg/kg	3.929	707.23 mg/kg	0.0707 %			
6	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	94 mg/kg	1.56	146.623 mg/kg	0.0094 %			
7	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		0.46 mg/kg	1.353	0.623 mg/kg	0.0000623 %			
8	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		22 mg/kg	2.976	65.478 mg/kg	0.00655 %			
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				0.58 mg/kg	2.554	1.481 mg/kg	0.000148 %			
10	zinc { zinc chromate }	024-007-00-3				91 mg/kg	2.774	252.447 mg/kg	0.0252 %			
11	naphthalene	601-052-00-2	202-049-5	91-20-3		0.64 mg/kg		0.64 mg/kg	0.000064 %			
12	acenaphthylene		205-917-1	208-96-8		0.23 mg/kg		0.23 mg/kg	0.000023 %			
13	acenaphthene		201-469-6	83-32-9		0.34 mg/kg		0.34 mg/kg	0.000034 %			
14	fluorene		201-695-5	86-73-7		0.36 mg/kg		0.36 mg/kg	0.000036 %			

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number							
15	phenanthrene	201-581-5	85-01-8		2.6 mg/kg		2.6 mg/kg	0.00026 %		
16	anthracene	204-371-1	120-12-7		1.1 mg/kg		1.1 mg/kg	0.00011 %		
17	fluoranthene	205-912-4	206-44-0		6.1 mg/kg		6.1 mg/kg	0.00061 %		
18	pyrene	204-927-3	129-00-0		5.1 mg/kg		5.1 mg/kg	0.00051 %		
19	benzo[a]anthracene	601-033-00-9	200-280-6		3.4 mg/kg		3.4 mg/kg	0.00034 %		
20	chrysene	601-048-00-0	205-923-4		4.7 mg/kg		4.7 mg/kg	0.00047 %		
21	benzo[k]fluoranthene	601-036-00-5	205-916-6		1.7 mg/kg		1.7 mg/kg	0.00017 %		
22	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		2.6 mg/kg		2.6 mg/kg	0.00026 %		
23	dibenz[a,h]anthracene	601-041-00-2	200-181-8		0.68 mg/kg		0.68 mg/kg	0.000068 %		
24	benzo[ghi]perylene	205-883-8	191-24-2		2.3 mg/kg		2.3 mg/kg	0.00023 %		
25	indeno[123-cd]pyrene	205-893-2	193-39-5		2 mg/kg		2 mg/kg	0.0002 %		
26	TPH (C6 to C40) petroleum group		TPH		25 mg/kg		25 mg/kg	0.0025 %		
27	confirm TPH has NOT arisen from diesel or petrol				☒					
Total:								0.124 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Supplementary Hazardous Property Information

HP 3(i): Flammable "flammable liquid waste: liquid waste having a flash point below 60°C or waste gas oil, diesel and light heating oils having a flash point > 55°C and <= 75°C"

Force this Hazardous property to non hazardous because Sample unlikely to be Flammable

Hazard Statements hit:

Flam. Liq. 3; H226 "Flammable liquid and vapour."

Because of determinand:

TPH (C6 to C40) petroleum group: (conc.: 0.0025%)

Classification of sample: TP5

 **Hazardous Waste**
Classified as **17 05 03 ***
in the List of Waste

Sample details

Sample Name:	TP5	LoW Code:	Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	0.60 m	Entry:	17 05 03 * (Soil and stones containing hazardous substances)	
Moisture content:	18%			
	(no correction)			

Hazard properties

HP 7: Carcinogenic "waste which induces cancer or increases its incidence"

Hazard Statements hit:

Carc. 1A; H350 "May cause cancer [state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard]."

Because of determinand:

zinc chromate: (compound conc.: 0.108%)

Determinands

Moisture content: 18% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number								
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3	33 mg/kg	1.32	43.571 mg/kg	0.00436 %			
2	cadmium { cadmium sulfide }	048-010-00-4	215-147-8	1306-23-6	0.63 mg/kg	1.285	0.81 mg/kg	0.000063 %			
3	chromium in chromium(III) compounds { chromium(III) oxide }	215-160-9	1308-38-9		23 mg/kg	1.462	33.616 mg/kg	0.00336 %			
4	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0	<0.5 mg/kg	1.923	<0.962 mg/kg	<0.0000962 %			<LOD
5	copper { copper sulphate pentahydrate }	029-023-00-4	231-847-6	7758-99-8	74 mg/kg	3.929	290.75 mg/kg	0.0291 %			
6	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	280 mg/kg	1.56	436.748 mg/kg	0.028 %			
7	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7	0.98 mg/kg	1.353	1.326 mg/kg	0.000133 %			
8	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7	32 mg/kg	2.976	95.24 mg/kg	0.00952 %			
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8			1.4 mg/kg	2.554	3.575 mg/kg	0.000358 %			
10	zinc { zinc chromate }	024-007-00-3			390 mg/kg	2.774	1081.917 mg/kg	0.108 %			

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number							
11	naphthalene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
	601-052-00-2	202-049-5	91-20-3							
12	acenaphthylene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		205-917-1	208-96-8							
13	acenaphthene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		201-469-6	83-32-9							
14	fluorene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		201-695-5	86-73-7							
15	phenanthrene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		201-581-5	85-01-8							
16	anthracene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		204-371-1	120-12-7							
17	fluoranthene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		205-912-4	206-44-0							
18	pyrene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		204-927-3	129-00-0							
19	benzo[a]anthracene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
	601-033-00-9	200-280-6	56-55-3							
20	chrysene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
	601-048-00-0	205-923-4	218-01-9							
21	benzo[k]fluoranthene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
	601-036-00-5	205-916-6	207-08-9							
22	benzo[a]pyrene; benzo[def]chrysene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
	601-032-00-3	200-028-5	50-32-8							
23	dibenz[a,h]anthracene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
	601-041-00-2	200-181-8	53-70-3							
24	benzo[ghi]perylene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		205-883-8	191-24-2							
25	indeno[123-cd]pyrene				<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
		205-893-2	193-39-5							
26	TPH (C6 to C40) petroleum group				<10 mg/kg		<10 mg/kg	<0.001 %		<LOD
			TPH							
27	confirm TPH has NOT arisen from diesel or petrol				☒					
Total:								0.184 %		

Key

- User supplied data
- Determinand values ignored for classification, see column 'Conc. Not Used' for reason
- Hazardous result
- Determinand defined or amended by HazWasteOnline (see Appendix A)
- Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
- <LOD** Below limit of detection
- CLP: Note 1 Only the metal concentration has been used for classification

Classification of sample: WS1

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	WS1	LoW Code:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	0.50 m	Chapter:	17 05 04 (Soil and stones other than those mentioned in 17 05 03)
Moisture content:	12%	Entry:	
	(no correction)		

Hazard properties

None identified

Determinands

Moisture content: 12% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number									
1	arsenic { arsenic trioxide }				12	mg/kg	1.32	15.844	mg/kg	0.00158 %		
	033-003-00-0	215-481-4	1327-53-3									
2	cadmium { cadmium sulfide }			1	0.14	mg/kg	1.285	0.18	mg/kg	0.000014 %		
	048-010-00-4	215-147-8	1306-23-6									
3	chromium in chromium(III) compounds { chromium(III) oxide }				18	mg/kg	1.462	26.308	mg/kg	0.00263 %		
		215-160-9	1308-38-9									
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<0.5	mg/kg	1.923	<0.962	mg/kg	<0.0000962 %		<LOD
	024-001-00-0	215-607-8	1333-82-0									
5	copper { copper sulphate pentahydrate }				20	mg/kg	3.929	78.581	mg/kg	0.00786 %		
	029-023-00-4	231-847-6	7758-99-8									
6	lead { lead chromate }			1	29	mg/kg	1.56	45.235	mg/kg	0.0029 %		
	082-004-00-2	231-846-0	7758-97-6									
7	mercury { mercury dichloride }				<0.1	mg/kg	1.353	<0.135	mg/kg	<0.0000135 %		<LOD
	080-010-00-X	231-299-8	7487-94-7									
8	nickel { nickel chromate }				28	mg/kg	2.976	83.335	mg/kg	0.00833 %		
	028-035-00-7	238-766-5	14721-18-7									
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				0.2	mg/kg	2.554	0.511	mg/kg	0.0000511 %		
	034-002-00-8											
10	zinc { zinc chromate }				55	mg/kg	2.774	152.578	mg/kg	0.0153 %		
	024-007-00-3											
11	naphthalene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
	601-052-00-2	202-049-5	91-20-3									
12	acenaphthylene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		205-917-1	208-96-8									
13	acenaphthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		201-469-6	83-32-9									
14	fluorene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		201-695-5	86-73-7									

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number							
15	phenanthrene	201-581-5	85-01-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
16	anthracene	204-371-1	120-12-7		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
17	fluoranthene	205-912-4	206-44-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
18	pyrene	204-927-3	129-00-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
19	benzo[a]anthracene	601-033-00-9	200-280-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
20	chrysene	601-048-00-0	205-923-4		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
21	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
22	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
23	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
24	benzo[ghi]perylene	205-883-8	191-24-2		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
26	TPH (C6 to C40) petroleum group		TPH		<10 mg/kg		<10 mg/kg	<0.001 %		<LOD
27	confirm TPH has NOT arisen from diesel or petrol				☒					
Total:								0.0399 %		

Key

- User supplied data
- Determinand values ignored for classification, see column 'Conc. Not Used' for reason
- Determinand defined or amended by HazWasteOnline (see Appendix A)
- Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
- <LOD Below limit of detection
- CLP: Note 1 Only the metal concentration has been used for classification

Classification of sample: WS2

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	WS2	LoW Code:	Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	1.10 m	Entry:		17 05 04 (Soil and stones other than those mentioned in 17 05 03)
Moisture content:	13%			
	(no correction)			

Hazard properties

None identified

Determinands

Moisture content: 13% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number									
1	 arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3	1	12	mg/kg	1.32	15.844	mg/kg	0.00158 %	
2	 cadmium { cadmium sulfide }	048-010-00-4	215-147-8	1306-23-6		0.17	mg/kg	1.285	0.218	mg/kg	0.000017 %	
3	 chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		17	mg/kg	1.462	24.846	mg/kg	0.00248 %	
4	 chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<0.5	mg/kg	1.923	<0.962	mg/kg	<0.0000962 %	<LOD
5	 copper { copper sulphate pentahydrate }	029-023-00-4	231-847-6	7758-99-8		24	mg/kg	3.929	94.297	mg/kg	0.00943 %	
6	 lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	34	mg/kg	1.56	53.034	mg/kg	0.0034 %	
7	 mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		0.5	mg/kg	1.353	0.677	mg/kg	0.0000677 %	
8	 nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		22	mg/kg	2.976	65.478	mg/kg	0.00655 %	
9	 selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				0.72	mg/kg	2.554	1.839	mg/kg	0.000184 %	
10	 zinc { zinc chromate }	024-007-00-3				64	mg/kg	2.774	177.545	mg/kg	0.0178 %	
11	naphthalene	601-052-00-2	202-049-5	91-20-3		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %	<LOD
12	acenaphthylene		205-917-1	208-96-8		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %	<LOD
13	acenaphthene		201-469-6	83-32-9		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %	<LOD
14	fluorene		201-695-5	86-73-7		<0.1	mg/kg		<0.1	mg/kg	<0.00001 %	<LOD

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number							
15	phenanthrene	201-581-5	85-01-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
16	anthracene	204-371-1	120-12-7		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
17	fluoranthene	205-912-4	206-44-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
18	pyrene	204-927-3	129-00-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
19	benzo[a]anthracene	601-033-00-9	200-280-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
20	chrysene	601-048-00-0	205-923-4		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
21	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
22	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
23	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
24	benzo[ghi]perylene	205-883-8	191-24-2		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
26	TPH (C6 to C40) petroleum group		TPH		<10 mg/kg		<10 mg/kg	<0.001 %		<LOD
27	confirm TPH has NOT arisen from diesel or petrol				☒					
Total:								0.0427 %		

Key

- User supplied data
- Determinand values ignored for classification, see column 'Conc. Not Used' for reason
- Determinand defined or amended by HazWasteOnline (see Appendix A)
- Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
- <LOD** Below limit of detection
- CLP: Note 1 Only the metal concentration has been used for classification

Classification of sample: WS5

 **Non Hazardous Waste**
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:	WS5	LoW Code:	Chapter:	17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Sample Depth:	0.60 m	Entry:		17 05 04 (Soil and stones other than those mentioned in 17 05 03)
Moisture content:	14%			
	(no correction)			

Hazard properties

None identified

Determinands

Moisture content: 14% No Moisture Correction applied (MC)

#	Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number									
1	arsenic { arsenic trioxide }				11	mg/kg	1.32	14.524	mg/kg	0.00145 %		
	033-003-00-0	215-481-4	1327-53-3									
2	cadmium { cadmium sulfide }			1	0.45	mg/kg	1.285	0.578	mg/kg	0.000045 %		
	048-010-00-4	215-147-8	1306-23-6									
3	chromium in chromium(III) compounds { chromium(III) oxide }				19	mg/kg	1.462	27.77	mg/kg	0.00278 %		
		215-160-9	1308-38-9									
4	chromium in chromium(VI) compounds { chromium(VI) oxide }				<0.5	mg/kg	1.923	<0.962	mg/kg	<0.0000962 %		<LOD
	024-001-00-0	215-607-8	1333-82-0									
5	copper { copper sulphate pentahydrate }				23	mg/kg	3.929	90.368	mg/kg	0.00904 %		
	029-023-00-4	231-847-6	7758-99-8									
6	lead { lead chromate }			1	25	mg/kg	1.56	38.995	mg/kg	0.0025 %		
	082-004-00-2	231-846-0	7758-97-6									
7	mercury { mercury dichloride }				0.14	mg/kg	1.353	0.189	mg/kg	0.0000189 %		
	080-010-00-X	231-299-8	7487-94-7									
8	nickel { nickel chromate }				27	mg/kg	2.976	80.359	mg/kg	0.00804 %		
	028-035-00-7	238-766-5	14721-18-7									
9	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }				0.49	mg/kg	2.554	1.251	mg/kg	0.000125 %		
	034-002-00-8											
10	zinc { zinc chromate }				59	mg/kg	2.774	163.675	mg/kg	0.0164 %		
	024-007-00-3											
11	naphthalene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
	601-052-00-2	202-049-5	91-20-3									
12	acenaphthylene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		205-917-1	208-96-8									
13	acenaphthene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		201-469-6	83-32-9									
14	fluorene				<0.1	mg/kg		<0.1	mg/kg	<0.00001 %		<LOD
		201-695-5	86-73-7									

#	Determinand			CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number	EC Number	CAS Number							
15	phenanthrene	201-581-5	85-01-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
16	anthracene	204-371-1	120-12-7		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
17	fluoranthene	205-912-4	206-44-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
18	pyrene	204-927-3	129-00-0		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
19	benzo[a]anthracene	601-033-00-9	200-280-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
20	chrysene	601-048-00-0	205-923-4		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
21	benzo[k]fluoranthene	601-036-00-5	205-916-6		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
22	benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
23	dibenz[a,h]anthracene	601-041-00-2	200-181-8		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
24	benzo[ghi]perylene	205-883-8	191-24-2		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
25	indeno[123-cd]pyrene	205-893-2	193-39-5		<0.1 mg/kg		<0.1 mg/kg	<0.00001 %		<LOD
26	TPH (C6 to C40) petroleum group		TPH		<10 mg/kg		<10 mg/kg	<0.001 %		<LOD
27	confirm TPH has NOT arisen from diesel or petrol				☒					
Total:								0.0416 %		

Key

- User supplied data
- Determinand values ignored for classification, see column 'Conc. Not Used' for reason
- Determinand defined or amended by HazWasteOnline (see Appendix A)
- Speciated Determinand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
- <LOD** Below limit of detection
- CLP: Note 1 Only the metal concentration has been used for classification

Appendix A: Classifier defined and non CLP determinands

■ **chromium(III) oxide** (EC Number: 215-160-9, CAS Number: 1308-38-9)

Conversion factor: 1.462

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Repr. 1B H360FD , Skin Sens. 1 H317 , Resp. Sens. 1 H334 , Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Acute Tox. 4 H302 , Acute Tox. 4 H332

■ **acenaphthylene** (EC Number: 205-917-1, CAS Number: 208-96-8)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Acute Tox. 1 H310 , Acute Tox. 1 H330 , Acute Tox. 4 H302

■ **acenaphthene** (EC Number: 201-469-6, CAS Number: 83-32-9)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Aquatic Chronic 2 H411 , Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319

■ **fluorene** (EC Number: 201-695-5, CAS Number: 86-73-7)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 06 Aug 2015

Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400

■ **phenanthrene** (EC Number: 201-581-5, CAS Number: 85-01-8)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 06 Aug 2015

Hazard Statements: Skin Irrit. 2 H315 , Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Skin Sens. 1 H317 , Carc. 2 H351 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Acute Tox. 4 H302

■ **anthracene** (EC Number: 204-371-1, CAS Number: 120-12-7)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 17 Jul 2015

Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Skin Sens. 1 H317 , Skin Irrit. 2 H315 , STOT SE 3 H335 , Eye Irrit. 2 H319

■ **fluoranthene** (EC Number: 205-912-4, CAS Number: 206-44-0)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 21 Aug 2015

Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , Acute Tox. 4 H302

■ **pyrene** (EC Number: 204-927-3, CAS Number: 129-00-0)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 2014

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 21 Aug 2015

Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400 , STOT SE 3 H335 , Eye Irrit. 2 H319 , Skin Irrit. 2 H315

■ **benzo[ghi]perylene** (EC Number: 205-883-8, CAS Number: 191-24-2)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 28/02/2015

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 23 Jul 2015

Hazard Statements: Aquatic Chronic 1 H410 , Aquatic Acute 1 H400

▪ **indeno[123-cd]pyrene** (EC Number: 205-893-2, CAS Number: 193-39-5)

Description/Comments: Data from C&L Inventory Database

Data source: <http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database>

Data source date: 06 Aug 2015

Hazard Statements: Carc. 2 H351

▪ **TPH (C6 to C40) petroleum group** (CAS Number: TPH)

Description/Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013

Data source: WM3 1st Edition 2015

Data source date: 25 May 2015

Hazard Statements: Aquatic Chronic 2 H411, Repr. 2 H361d, Carc. 1B H350, Muta. 1B H340, STOT RE 2 H373, Asp. Tox. 1 H304, Flam. Liq. 3 H226

▪ **confirm TPH has NOT arisen from diesel or petrol**

Description/Comments: Chapter 3, section 4b requires a positive confirmation for benzo[a]pyrene to be used as a marker in evaluating Carc. 1B; H350 (HP 7) and Muta. 1B; H340 (HP 11)

Data source: WM3 1st Edition 2015

Data source date: 25 May 2015

Hazard Statements: None.

Appendix B: Rationale for selection of metal species

arsenic {arsenic trioxide}

(enter justification for selecting this species)

cadmium {cadmium sulfide}

(enter justification for selecting this species)

chromium in chromium(III) compounds {chromium(III) oxide}

(enter justification for selecting this species)

chromium in chromium(VI) compounds {chromium(VI) oxide}

(enter justification for selecting this species)

copper {copper sulphate pentahydrate}

(enter justification for selecting this species)

lead {lead chromate}

(enter justification for selecting this species)

mercury {mercury dichloride}

(enter justification for selecting this species)

nickel {nickel chromate}

(enter justification for selecting this species)

selenium {selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex}

(enter justification for selecting this species)

zinc {zinc chromate}

(enter justification for selecting this species)

Appendix C: Version

HazWasteOnline Classification Engine: WM3 1st Edition v1.1, May 2018

HazWasteOnline Classification Engine Version: 2018.247.3619.7425 (04 Sep 2018)

HazWasteOnline Database: 2018.247.3619.7425 (04 Sep 2018)



This classification utilises the following guidance and legislation:

WM3 v1.1 - Waste Classification - 1st Edition v1.1 - May 2018

CLP Regulation - Regulation 1272/2008/EC of 16 December 2008

1st ATP - Regulation 790/2009/EC of 10 August 2009

2nd ATP - Regulation 286/2011/EC of 10 March 2011

3rd ATP - Regulation 618/2012/EU of 10 July 2012

4th ATP - Regulation 487/2013/EU of 8 May 2013

Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013

5th ATP - Regulation 944/2013/EU of 2 October 2013

6th ATP - Regulation 605/2014/EU of 5 June 2014

WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014

Revised List of Wastes 2014 - Decision 2014/955/EU of 18 December 2014

7th ATP - Regulation 2015/1221/EU of 24 July 2015

8th ATP - Regulation (EU) 2016/918 of 19 May 2016

9th ATP - Regulation (EU) 2016/1179 of 19 July 2016

10th ATP - Regulation (EU) 2017/776 of 4 May 2017

HP14 amendment - Regulation (EU) 2017/997 of 8 June 2017

POPs Regulation 2004 - Regulation 850/2004/EC of 29 April 2004

1st ATP to POPs Regulation - Regulation 756/2010/EU of 24 August 2010

2nd ATP to POPs Regulation - Regulation 757/2010/EU of 24 August 2010

APPENDIX E: - CONTAMINATION RISK ASSESSMENT METHODOLOGY AND DEFINITIONS

CONTAMINATION ASSESSMENT METHODOLOGY

The DEFRA and Environment Agency Contaminated Land Report 11 (CLR11) 'Model Procedures for the Management of Land Contamination' provides a technical framework for structured decision making about land contamination.

A1. Definition of Risk

CLR11 defines risk as "a combination of probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence".

A2. The Concept of the 'Pollutant Linkage'

In the context of contaminated land, there are three essential elements to any risk:

- a **contaminant (or source)** – a substance that is in, on or under land and has the potential to cause harm or cause pollution of controlled waters.
- a **receptor** - humans, ecological system, water body or property.
- a **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Each of these elements can exist separately; however, they create a risk only where they are linked together forming a **pollutant linkage**.

A3. Conceptual Site Models

A conceptual site model represents the characteristics of the site in diagrammatic or written form that shows the possible relationships between contaminants, pathways and receptors (pollutant linkages).

For all potential pollutant linkages identified, the *consequence* and *probability* of occurrence is qualitatively assessed, and a *risk* assigned.

A4. The Tiered Risk Assessment Approach

CLR11 presents a tiered approach to risk:

Tier 1 *Preliminary risk assessment (PRA)*

The purpose of the preliminary risk assessment is to develop an initial conceptual model of the site and to establish whether there are potentially unacceptable risks. If potential risks are identified the initial conceptual model is developed in subsequent tiers of the risk assessment process.

Tier 2 *Generic quantitative risk assessment (GQRA)*

The purpose of the generic quantitative risk assessment is to establish whether generic assessment criteria and assumptions are appropriate for assessing the risks and, if so, to apply them to establish whether there are actual or potential unacceptable risks. It also determines whether further detailed quantitative risk assessment is required.

Tier 3 *Detailed quantitative risk assessment (DQRA)*

The purpose of the detailed quantitative risk assessment is to establish and use more detailed site-specific information and criteria to decide whether there are unacceptable risks. It may be used as the sole method of quantitative assessments of risks, or it may be used to refine earlier assessments using generic assessment criteria.

B. RISK ASSESSMENT DEFINITIONS

B1. General

The following classification and definition of risk assessment has been based on that set out in NHBC and EA Publication R&D 66 – Guidance on the Safe Development of Housing on Land Affected by Contamination (2008).

The key to the classification is that the designation of risk is based upon the consideration of both:

- the magnitude of the potential consequence (i.e. severity)**, which considers both the potential severity of the hazard, and the sensitivity of the receptor.
- the magnitude of probability (i.e. likelihood)**, which considers both the presence of the hazard, the receptor, and the integrity of the pathway.

B2. Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

* For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned.

B3. Classification of Probability

Only applies if there is a possibility of a pollutant linkage being present.

Classification	Definition	Examples
High likelihood	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	a) Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden. b) Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50
Likely	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	a) Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space. b) Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.
Low likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.	a) Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space. b) Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	a) Elevated concentrations of toxic contaminants are present below hard standing. b) Light industrial unit <10 yrs. old containing a double-skinned UST with annual integrity testing results available.

Note: A pollution linkage must first be established before probability is classified. If there is no pollution linkage, then there is no potential risk. If there is no pollution linkage, then there is no need to apply tests for probability and consequence.

For example, if there is surface contamination and a major aquifer is present at depth, but this major aquifer is overlain by an aquiclude of significant thickness then there is no pollution linkage and the risks to the major aquifer are not assessed. The report should identify both the source and the receptor but state that because there is no linkage there are no potential risks.

B4. The Classification of Risk

Probability		Consequence			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

B5. Description of the Classified Risks

Very high risk

There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.

High risk

Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.

Moderate risk

It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk

It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk

It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

No potential risk

There is no potential risk if no pollution linkage has been established.

B6. Definitions

Term	Definition
Hazard	A property or situation which in certain circumstances could lead to harm. The properties of different hazards must be assessed in relation to their potential to affect the various receptors.
Risk	A combination of the probability or frequency of the occurrences of a defined hazard AND the magnitude of the consequences of that occurrence.
Probability	The mathematical expression of the chance of a particular event in a given period of time [e.g. probability of 0.2 is equivalent to 20% or a 1 in 5 chance].
Impact	The adverse effects (or harm) arising from a defined hazard which impairs the quality of the environment or human health in the short or longer term.
Pollution linkage	An identified pathway is capable of exposing a receptor to a contaminant and that contaminant is capable of harming the receptor.

APPENDIX F - LIMITATIONS AND EXCEPTIONS

Limitations and Exceptions

1. The advice given in this report is based on the guidelines available at the time of writing.
2. This investigation was conducted so as to generally comply with the relevant principles and requirements of BS10175: 2011 "Investigation of potentially contaminated sites - Code of Practice" and BS 5930:2015 "Code of Practice for Site Investigations".
3. The Client is advised that the conditions observed on site by Jubb Consulting Engineers Ltd (JCE) at the time of the investigation or assessment are subject to change. Certain indicators of the presence of hazardous substances may have been latent at the time of the most recent site reconnaissance or investigation and they may subsequently have become observable. Ground conditions, including geotechnical properties may vary between points of observation, sampling and testing.
4. Certain areas of site had restricted access or were inaccessible due to the presence of in-use buildings, facilities and live services, as identified in this report. These may require further investigation outside the scope of this present investigation.
5. Comments made relating to land gas or groundwater conditions are based on observations made at the time of an investigation unless otherwise stated. Land gas and groundwater conditions may vary as a result of seasonal or other effects.
6. Ground contamination often exists as small discrete areas of contamination and there can be no certainty that any or all such areas have been located, sampled and/or identified.
7. The findings and opinions conveyed in this report are based on information obtained from a variety of sources, including that from previous site investigations and chemical and geotechnical testing laboratories, and which JCE has assumed are correct. Nevertheless, JCE cannot and does not guarantee the authenticity or reliability of the information it has used or cited. JCE can accept no responsibility for inaccuracies within the data supplied by other parties.
8. This report is written in the context of an agreed scope of work between JCE and the Client and should not be used in a different context. In the light of additional information becoming available, improved practices and changes in legislation, amendment or re-interpretation of the assessment or report in whole or part may be necessary after its original submission.
9. This report is provided for sole use by the Client and is confidential to them. No responsibility whatsoever for the contents of the report will be accepted to anyone other than the Client.
10. This report is not a specification for works.
11. JCE believes that providing information about limitations is essential to help the Client identify and thereby manage risks.
12. JCE does not provide legal advice and the advice of the Clients' legal advisors may also be required.
13. JCE retain the copyright in this report and all drawings reproduced in it.