

VolkerFitzpatrick Limited

MetroWest Phase 1B

GRIP 5 Ground Investigation Report (BCC)

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This report takes into account the particular instructions and requirements of our client.

Job number 293556

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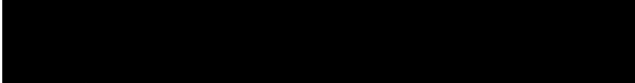
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1. Introduction

1.1 This Document

This document has been produced by Arup on behalf of Network Rail to discharge Requirement 17 of the Portishead Branch Line (MetroWest Phase 1) Order 2022 (the Development Consent Order which will be referred to as “DCO” in this document) [1].

Requirement 17 of the DCO states that:

- (1) Any stage of the authorised development must not commence until a written scheme applicable to that stage to deal with the contamination of any land, including groundwater, within the Order limits which is likely to cause significant harm to persons or pollution of controlled waters or the environment has, after consultation with the relevant planning authority and the Environment Agency, been submitted to and approved by the relevant planning authority.
- (2) The scheme must include an investigation and assessment report (including a desk based study – already produced by Arup [2]), prepared by a specialist consultant approved by the relevant planning authority, to identify the extent of any contamination and the remedial measures to be taken with respect to any contaminants on the site.
- (3) The stage of the authorised development must be carried out in accordance with the approved scheme.
- (4) Where the scheme sets out remedial measures to be taken with respect to any contaminants on the site, a verification plan must also be submitted providing details of the data that will be collected in order to demonstrate that the remedial measures are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.
- (5) If, during development, contamination not previously identified is found to be present at the site, no further development (unless otherwise agreed in writing with the relevant planning authority) is to be carried out until a remediation strategy detailing how this unsuspected contamination will be dealt with has, after consultation with the relevant planning authority and the Environment Agency, been submitted to and approved by the relevant planning authority. The remediation strategy must be implemented as approved.
- (6) Paragraphs (1) to (5) do not apply to any currently operational railway land.

This document has been prepared for submission to Bristol City Council in support of the discharge Requirement 17 sub part (2) for the detailed design (GRIP 5) of MetroWest Phase 1.

1.2 Project Description

The MetroWest Phase 1 project aims to reconnect Bristol and Portishead by rail, providing the capability to introduce an hourly or hourly-plus passenger service from Bristol Temple Meads to Pill and Portishead. The project consists of the following key components:

The re-opening of a passenger service between a new Portishead station and Bristol Temple Meads, including reopening a freight line to passenger traffic and 4.68km of new railway to be constructed on the disused line between Pill and Portishead.

New Stations at Pill and Portishead and twin tracking through the Pill area.

Improvement works to the existing freight line between Portbury Junction and Parson Street Junction.

Highway works in the Portishead and Winterstoke Road, Bristol areas.

Access improvements, new highway accesses, new or altered bridleways, and new or altered pedestrian and cycle routes.

Construction of permanent rail maintenance compounds and Road/Rail Access Points (RRAP).

In addition to the works above, a number of temporary sites will be established along the route for compounds and haul roads, some of these will later become permanent railway access points. A number of these sites were identified by North Somerset Council (NSC) and West of England Combined Authority (WECA) as requiring further investigation to establish the following:

Structure of the soil to inform the design of temporary haul roads and compounds and permanent compounds, paths, and highways,

to inform on the understanding of settlement periods for new works based on the stability of the ground, and

to identify contaminants in the soil which may affect how the soil is managed and disposed of [3].

The majority of the proposed scheme including the NSC and WECA temporary sites lie within the NSC district and as such were assessed within a separate report (140569-VLF-WST-POD-REP-EGE-000004) which has been submitted to NSC.

The following report covers the single non-operational railway site within Bristol City Councils (BCC) district. This site is known as site 13 ('the site') located off Clanage Road at scheme chainage Ch195800m - Ch195600m.

Site 14 which was included in the scope of the Desk Study [2] was excluded from further consideration on the basis that the proposed works in this area were alterations to the existing carriageway and temporary use as a site lay down area/compound. On this basis it was considered that the potential risks in relation to human health and controlled waters were minimal.

Development Consent was granted for the above works by the Department for Transport on 14/11/2022 following consideration by the Secretary of State for Transport and the Planning Inspectorate.

1.3 Scope and Objectives

Ove Arup & Partners Ltd (Arup) have been commissioned by VolkerFitzpatrick to provide multi-disciplinary support for the detailed design (GRIP 5 - 8) of MetroWest Phase 1. The development is covered by the DCO boundary.

Requirement 17, sub part 6 [1], limits Requirement 17 to only the non-operational railway parts of the proposed scheme. As such, since the rail infrastructure within BCCs jurisdiction is operational as a freight line this area is excluded from the DCO conditions. On this basis, Site 13 is the only part of the scheme in BCC district located outside the area of operational rail and as such has (Clanage Road - BCC's authority) is the focus of this report.

The purpose of this GIR is to:

Review general background information available at the time of writing.

Summarise all details of ground investigations undertaken and all available geo-environmental information.

Present the interpreted ground and groundwater conditions.

Assess potential risks to human health and controlled waters and suitability of materials for re-use.

Provide conclusions and recommendations for any further works.

1.4 Limitations

This report has been prepared for the use by VolkerFitzpatrick and takes into consideration their particular instructions and requirements.

2. Development Proposals

As part of the desk study [2] a Conceptual Site Model (CSM) was developed based on the proposed works through the non-operational railways areas for the Temporary/Satellite Sites (including the Clanage Road site which is the subject of this report), and the likely contamination risks and receptors which need to be assessed.

In line with the conditions outlined in the DCO, Arup we have reviewed and assessed the relevant sites to BCC not included within the boundaries of operational railway land. This section reviews information for the temporary site, reserved for construction compounds, and permanent works within proximity to the railway.

Site 13 (see (Figure 1) will comprise a temporary construction compound providing access from the A369 Clanage Road to the railway. Following completion of the development, the northern half of the temporary site will be converted into a RRAP for future railway maintenance. Additionally, the southern tip of the site will also become a permanent vehicular access point to the adjoining land.

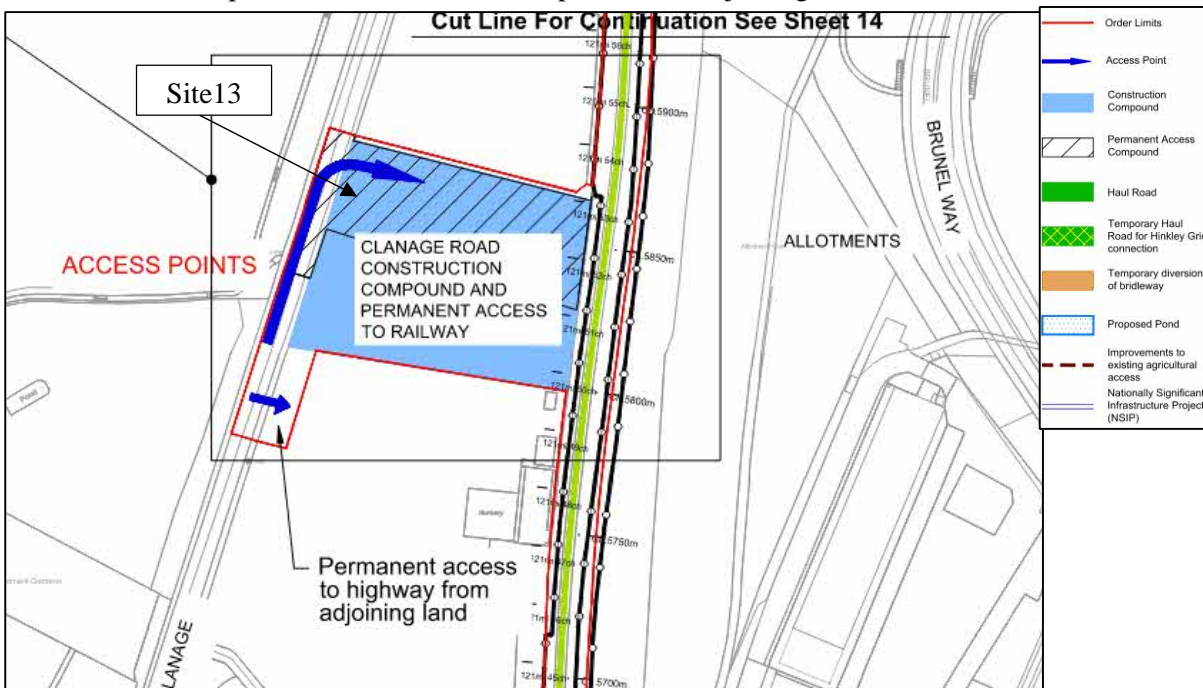


Figure 1: Proposed works for Clanage Road (Site 13) [3].

3. Existing Information

3.1 Sources of Information

The desk study report prepared by Arup [2] and identification of Potential Contaminant Linkages (PCLs) formed the basis for the GI and the subsequent assessments carried out as part of this GIR. A list of the sources reviewed is included in the desk study report. In order to assist the reader, a summary of the desk study findings for each of the site, is provided in the following sections.

Table 1: Desk study summary

Site 13 - Clanage Road (Ch195800m - Ch195600m)	
Site Location and Description	<p>Predominantly undeveloped land with the railway trending north to south along the western edge of the site. Additionally, the A369 trends north to south on the eastern boundary of the site.</p> <p>The site is bounded to the west (beyond the A369) by agricultural fields, the east (beyond the railway) by allotment gardens, and to the south by sports grounds and commercial buildings. To the north of the site is the</p>

Site 13 - Clanage Road (Ch195800m - Ch195600m)	
	former Avon and Somerset Mounted and Dogs Section buildings which at the time of writing were dilapidated and disused.
Site History	<p><u>1883</u>: The site consisted of undeveloped land with the railway line trending north to south adjacent to the eastern site boundary and Clanage Road trending north to south on the western site boundary. The surrounding region predominantly consisted of undeveloped land east of the site, as this is subject to tidal flooding, and agricultural fields west of the site. Clifton Bridge Railway Station was present 210m north of north of the site. A tramway related to the operation of Frayne's Colliery to the south was present 60m east of the site boundary trending northeast to southwest.</p> <p><u>1902</u>: a collection of greenhouses was present 140m southwest of the site.</p> <p><u>1913</u>: The tramway east of the site was replaced by the Bristol lines Railway as well as several extra railway sidings.</p> <p><u>1947</u>: The site to the north (later Avon and Somerset Mounted and Dog Section) is occupied by allotment gardens.</p> <p><u>1973</u>: The A3029 (also referred to as Brunel Way) was constructed 120m east of the site trending north to south. Adjacent to the major roadway was a large unspecified warehouse approximately 250m southeast of the site as well as some industrial buildings at a closer distance of 150m southeast.</p> <p><u>2010</u>: The warehouse and railway infrastructure to the southeast of the site were demolished.</p>
Published Geology	<p><u>Superficial deposits</u>: Based on the BGS geological map, there is no Made Ground recorded on site. The site is underlain by Head Deposits in the southeastern half and Alluvium in the northwestern half. Tidal Flat Deposits are present to the north of the site. There are no BGS borehole records within or in close proximity of the site. A BGS borehole record (ref. ST57SW3/A-H) 200m to the east of the site reveals clay materials, which are likely to be Tidal Flat Deposits, to a depth of circa 5-8mBGL above sandstone.</p> <p><u>Bedrock</u>: The site is predominantly underlain by Mercia Mudstone (Halite and Mudstone), with Redcliffe Sandstone Member recorded on the eastern and northern boundaries. There is no BGS borehole or existing GI available within the site. A BGS borehole record (ref. ST57SW3/A-H) 200m to the east of the site reveals sandstone at circa 5-8mBGL.</p>
Hydrology	No hydrogeological features are present onsite. However, an unnamed stream is present on the opposing side of Clanage Road (A369), approximately 30m east of the site, flowing north-south and the culverted Longmoor Brook is present approximately 50m east of the site.
Hydrogeology	<p><u>Aquifer designations</u>:</p> <ul style="list-style-type: none"> Alluvium - Secondary A aquifer. Tidal Flat Deposits - Unproductive Head Deposits - Secondary undifferentiated aquifer. Mercia Mudstone – Halite and Mudstone Secondary B aquifer. Redcliffe Sandstone - Secondary A aquifer. <p><u>Groundwater vulnerability</u>:</p> <ul style="list-style-type: none"> High – areas that can easily transmit pollutants to groundwater, Redcliffe Sandstone Member. Low – areas that offer groundwater protection, associated with the Mercia Mudstone (Halite and Mudstone) and the peat deposits. Soluble rock risk associated with the bedrock. <p><u>Source protection zones</u>: None.</p>

3.2 Previous Ground Investigations

A GI was conducted by CJ Associates Geotechnical Limited in 2018 [4] to locate the underground gas main just north of the site.

The investigation comprised a single shallow trial pit (TP01) conducted next to Clanage Road (A369), just north of the site. The trial pit indicates at least 1m thick of concrete at the north-western end of the site. The groundwater table was not encountered in the trial pit so is anticipated to be deeper than 1m bgl.

No sampling and analysis of soils was undertaken as part of the investigation.

3.3 Contamination Potential & Tier 1 Preliminary Risk Assessment

Based on the site’s historical and current uses, it was considered that there was a potential for contamination to be present from the following potential sources:

On-site:

Possible Made Ground associated with the construction of nearby transport infrastructure (railway and A369) - Asbestos, heavy metals, sulphates, phenols, TPH and PAH.

Off-site:

Railway land may contain hydrocarbons (including diesel, lubricating oils, paraffin), PAHs, solvents, metals (ferrous residues, metal fines), ash and fill (possibly containing metals, phenols, sulphates, and PAHs). Possible historic herbicides used to control growth on tracks and sidings.

Allotment gardens to the north may include ash and as such a source of PAHs and potential heavy metals from historic pesticide use.

On the basis of the Preliminary Risk Assessment a number of potential contaminant sources were identified as posing a moderate/low to moderate risk. On this basis site investigation was proposed to further define the risk. The following section presents the scope of the investigations and the PCLs targeted by this investigation.

4. Fieldwork

4.1 Completed Ground Investigation

The ground investigation specification was produced by Arup [5]. The intrusive investigations were undertaken by Geotechnical Engineering Limited.

The outline scope of the ground investigation was as follows:

Geotechnical and geo-environmental laboratory testing of soil samples obtained from exploratory holes.

4 No. windowless sample boreholes with dynamic cone penetrometer testing in two locations (2No. were originally specified as Trial Pits S13-TP01 and S13-TP02).

2 No. dynamic cone penetrometer tests (in addition to those conducted within the boreholes)

Further details on the completed GI are provided in the following sections and in Table 3.

4.2 Geo-environmental Scope

The desk study identified a number of Potential Contaminant Linkages (PCLs) which were initially assessed as part of the Preliminary Risk Assessment (Appendix B of the Desk Study [2]). Given the generally low sensitivity of the site and it’s end use, the majority of the PCLs were considered to present a Low risk and as such were not considered further. The following Table 2 summarises the PCLs that were assessed as having moderate/low and higher risk (note the numbering follows the PCL numbering presented in the Desk Study [2] for consistency).

Table 2: Identified PCLs as part of the desk study.

PCL ID	Potential Source	Potential Pathway	Potential Receptor
During Construction			

PCL ID	Potential Source	Potential Pathway	Potential Receptor
PCL 1	Contaminated Made Ground related to current and former railway infrastructure. (soils)	Dermal contact, ingestion and inhalation of soils and dust	Site construction workers
PCL 2	Contaminated groundwater	Dermal contact with groundwater	Site construction workers
PCL 5	Contaminated Made Ground across the site (leachate)	Preferential pathway for lateral migration along higher permeability horizons and leachate migration of temporarily stockpiled and exposed excavated soils	Off-site surface water receptors (unnamed stream and culverted Longmoor brook)
During Operation			
PCL 6	Contaminated Made Ground related to current and former railway infrastructure. (soils)	Dermal contact, ingestion and inhalation of soils and dust	Site maintenance workers

In order to address the above PCLs, the ground investigation comprised the following:

Sampling and testing of Made Ground soils for contamination (targeted samples related to the potential sources identified) to inform risks to construction workers and site neighbours (during construction) and site end users and maintenance workers (during operation) (refer to section 6.1).

Sampling and testing of soil leachate for contamination to inform on the risk with respect to controlled waters (underlying groundwater body within Mercia Mudstone/Redcliffe Sandstone) (refer to section 6.2).

In addition, the potential for aggressive ground in relation to buried concrete was also identified as part of the desk study.

4.3 Completed Fieldwork

The completed exploratory holes are summarised in Table 3 below:

Table 3 - Summary of exploratory locations

Location Type	Quantity	Depth Range (m BGL)	Remarks	PCL assessed
Site 13				
Windowless Sample boreholes (Dynamic Sampling)	2	6.20 - 6.25	S13-WS/DP01, S13-WS/DP02, Dynamic cone penetrometer testing, carried out alongside these boreholes.	PCL 1, PCL 2, PCL 5, PCL 6
Windowless Sample boreholes (replacement for Trial Pits)	2	3.50	TP01, TP02	PCL 1, PCL 2, PCL 5, PCL 6
Inspection pits (hand dug)	4	0.0 – 1.2	S13-WS/DP01, S13-WS/DP02, TP01, TP02	N/A

4.4 Laboratory Testing

Table 4 summarises the geo-environmental laboratory testing that was completed.

Table 4: Summary of completed laboratory testing.

Material	Geo-environmental testing	Potential sources of contamination identified by the desk study (see Note 1)
Soil	General suite including heavy metals, cyanide, pH, boron, phenols, and Total Organic Carbon (sulphates were covered by the BRE suite as part of the geotechnical testing to inform on concrete classification)	<p><u>On-site:</u></p> <p>Made ground associated with the construction of nearby transport infrastructure (railway and A369) - Asbestos, metals, phenols, sulphates.</p> <p>Railway land (Sites encompass and provide access to railway line - metals (ferrous residues, metal fines), ash and fill (possibly containing metals, phenols, sulphates).</p> <p><u>Off-site:</u></p> <p>Historical Railway Infrastructure (railway sidings) related to Frayne’s Colliery 60m east off-site - heavy metals, asbestos, phenols, and creosote.</p> <p>Allotment gardens</p>
	Asbestos identification (asbestos quantification testing was carried out if asbestos was identified in the soil samples tested)	
	Speciated Total Petroleum Hydrocarbons (TPH CWG)	<p><u>On-site:</u></p> <p>Made ground associated with the construction of nearby transport infrastructure (railway and A369) - TPH and PAH.</p> <p>Railway land (Sites encompass and provide access to railway line - Hydrocarbons (including diesel, lubricating oils, paraffin), PAHs, ash and fill (possibly containing PAHs).</p> <p><u>Off-site:</u></p> <p>Historical Railway Infrastructure (railway sidings) related to Frayne’s Colliery 60m east off-site - Hydrocarbons (including petroleum hydrocarbons and polycyclic aromatic hydrocarbons), fuel oils, lubricating oils.</p> <p>Allotment gardens</p>
	Speciated Polyaromatic Hydrocarbons (PAH USEPA 16) and BTEX	
	Hexavalent Chromium	Potential sources within site as above, and WAC testing was recommended to inform on their off-site disposal should this be required.
	WAC (Inert Suite) and leachability (including heavy metals, phenols, Dissolved Organic Carbon, Total Dissolved Solids, sulphate – reported in 2:1 and 10:1)	
Leachate	General suite including heavy metals, cyanide, pH, boron, phenols, and Total Organic Carbon	Potential sources identified across all site areas as above (soil testing) and leachate testing was recommended to inform on contamination potential related to leaching from Made Ground.
	Speciated PAH (USEPA 16) and BTEX	
<p><u>Notes:</u></p> <p>1. Identified sources at a distance greater than 100m from the site were not considered further on account of distance.</p>		

5. Ground Conditions

5.1 Encountered Ground Conditions

The encountered ground conditions relevant to the site are summarised in the sections below.

Table 5: Summary of encountered ground conditions.

Strata	Depth Encountered (m bgl)	General Description
Made Ground	0.40 to 0.50	Grass over brown to dark brown slightly gravelly clayey fine to coarse sand with frequent rootlets. Gravel is angular to subrounded fine and rarely medium mudstone and brick. In S13-WS/DP01, the Made Ground encountered between 0.15 and 0.50m bgl, was described as: Dark brown, black and locally reddish brown very sandy angular to subrounded fine to coarse brick and coal gravel with a high angular to subrounded brick and coal cobble content. Made Ground was not encountered in S13-WS/DP02
Superficial Deposits (Alluvium/Tidal Flat Deposits)	0.50 to 6.10	The superficial deposits encountered during the GI consisted of non-uniform layers of soft to very soft layers of clay and silt, described as brown to dark brown and grey to blueish grey. The material was described as being organic/having an organic odour within all exploratory holes.
Bedrock (Redcliffe Sandstone)	6.0 to an unproven depth	Extremely weak, light brown, fine to coarse sandstone was encountered in boreholes S13-WS/DP01 and S13-WS/DP02

Summary

The existing ground conditions consist of Made Ground/topsoil to depths of 0.40 to 0.50m bgl). Beneath the Made Ground/topsoil are layers of Alluvium/Tidal Flat Deposits, generally consisting of low permeability clay and silts with peat/organics to depths of up to 6.10m bgl. Bedrock consisting of extremely weak sandstone is present below the superficial deposits to an unproven depth.

Made Ground:

A review of the description of the Made Ground in the exploratory hole logs suggests that on the whole this material may constitute topsoil/subsoil with entrained anthropogenic materials.

A previous GI [6] indicated the presence of at least 1m thick concrete in the northwestern corner of the site. It is considered this is a localised feature as no concrete was identified during the recent investigations.

Superficial Deposits:

The published geology for the site [7] indicates that the northwestern corner is underlain by Alluvium, consisting of clay silt sand and gravel and Tidal flat Deposits, consisting of clay and silt. The rest of the site is indicated as being underlain by Head Deposits which are also described as consisting of clay silt sand and gravel.

The depths (m AOD) at which individual layers were encountered within boreholes was inconsistent across the locations. However, all the deposits consisted of soft to very soft layers of low permeability clay/silt, with the exception of the initial 0.8m of TP01, described as stiff reddish brown slightly sandy silty clay, (which may be reworked material due to the proximity of TP01 to the A369 road) and a layer of sand encountered at a depth of 3.55m AOD in S13-WS/DP01.

No clear distinction was made between TP01 (located in area of published Alluvium/Tidal Flat Deposits) and the rest of the exploratory holes (located within area of published Head deposits). In addition, the descriptions given in the logs note the presence of organic odour/ material within the superficial deposits.

Based on these descriptions, it is considered likely that the superficial deposits underlying the site consist of Alluvium/Tidal Flat Deposits, it is considered that the Head Deposits are not present on this site.

Bedrock:

Bedrock comprising of extremely weak, light brown, fine to coarse sandstone was encountered in boreholes S13-WS/DP01 and S13-WS/DP02 at depths of 6.00 to 6.10m bgl.

According to published BGS mapping, the site is underlain by the Mercia Mudstone (Halite and Mudstone) however the Redcliffe sandstone Member is mapped along the northern and southern site boundary (within 30m). Due to the proximity of the geological boundary and the limited recovery of the bedrock (the boreholes were completed after 0.25m penetration into bedrock) it is unclear whether the bedrock underlying the site consists of Mercia Mudstone (halite and mudstone) overlying the Redcliffe Sandstone or Redcliffe Sandstone is present directly beneath the superficial deposits.

5.2 Groundwater

A summary of the groundwater strikes recorded during the GI is provided in Table 6.

Table 6: Summary of groundwater strike records during GI

Location	Groundwater strike		Stratum (Note 1)	Depth of casing (m BGL)	Rose to (m BGL)	After (min)	Remarks
	Level (m AOD)	Depth (m BGL)					
S13-WS/DP01	5.55	2.10	ALV / TFD	2.00	2.10	0	Seepage
S13-WS/DP2	5.28	2.20	ALV / TFD	2.00	2.20	0	Seepage
TP01	6.35	1.20	ALV / TFD	Nil	--	--	--
TP02	6.15	1.25	ALV / TFD	Nil	0.90	20	Seepage

Note 1: MG – Made Ground / TFD – Tidal Flat Deposits / RTD – River Terrace Deposits / ALV – Alluvium / MMG – Mercia Mudstone Group

Post site works groundwater level monitoring was not undertaken as part of the site investigation.

A groundwater strike for TP01 was not recorded in the borehole logs (Appendix A). However, Photograph 1 indicates groundwater was encountered within TP01 at a maximum depth of 1.20m.

5.3 Evidence of Contamination during GI

The Made ground encountered during the GI included anthropogenic materials. This included brick, (encountered in S13-WS/DP01, TP01 and TP02) and coal (encountered in S13-WS/DP01). Aside from these there was no other visual or olfactory evidence of contamination given within the logs (Appendix A).

There was no visual evidence of asbestos or asbestos containing materials encountered during the GI. Asbestos identifications and quantification testing were undertaken as part of the GI and the results are included in Appendix B and Appendix C.

6. Geo-environmental Assessment

6.1 Human Health Tier 2 Generic Quantitative Risk Assessment (GQRA)

6.1.1 Introduction

The identified Potential Contaminant Linkages (PCLs) with respect to human health during construction (PCL1, PCL2) and during operation (PCL 6) have been assessed as part of the Human Health GQRA (refer to Table 2).

6.1.2 Assessment Methodology

To simplify the assessment of ground contamination risks, UK statutory guidance suggests that generic soil quality guideline values derived using the CLEA software [8] may be useful for initial screening of soil contamination testing results, provided that such guideline values are available and are appropriate to the site circumstances and the potential pollutant linkages in question. If the results from an adequate ground investigation are below such scientific and appropriate guidelines, then the site can be regarded as suitable for use. If the results exceed the screening guidelines, then more detailed investigation and/or site-specific risk assessment may be required to determine whether or not there is a need for remediation.

The assessment of risk to human health is undertaken in line with regulatory guidance (Environment Agency [9]) in the context of the conceptual site model and the PCLs identified.

Risk to construction workers (during construction) and maintenance workers (during operation)

Site construction workers involved in the development may be exposed to potentially contaminated soils including dust generated during earthworks as well as contaminated groundwater. Post development, maintenance workers involved in excavations may also be exposed to potentially contaminated soils, likely for shorter durations than construction workers. It is considered that the risks presented to the above identified receptors will be acute, rather than chronic, as these receptors will only be exposed to potentially contaminated soils for a short period of time. A human health risk assessment has been carried out in order to inform on the risk to construction workers.

In order to give an indication of potential risks posed to these short-term receptors (Construction Workers), the chemical analyses results have been screened against guideline values (S4ULs [10], C4SLs [11], and Arup GACs where relevant) for a residential without plant uptake land use scenario. Whilst it is acknowledged that given the receptors and exposure pathways during construction these guidance values will be conservative it is considered that they provide a useful initial screen of contaminants to identify potential risks to these receptors that may need specific consideration during site works.

Risk to site end users (during operation)

Due to limited site access, it is anticipated that site end users will consist only of railway workers accessing the railway via the RRAP. In order to assess the risk to human health to end site users, site soils have been screened against guideline values (S4ULs [10], C4SLs [11], and Arup GACs where relevant) for a commercial land use scenario. Given the end use it is considered that the commercial land use assessment criteria as likely to be conservative.

The applied assessment criteria and screening assessment are presented in Appendix B. Section 6.3 details the assessment carried out to inform on the suitability of the soils encountered as part of the GI for reuse within the development.

6.1.3 Soil Quality Assessment

The following samples have been analysed for a range of chemical determinands as detailed in Section 4.4:

- 1no. soil sample taken from 0.10-0.20m bgl in TP01.

1no. soil sample taken from 0.10-0.20m bgl in TP02.

2no soil sample taken from 0.05-0.10m bgl and 0.15-0.25m bgl in S13-WS/DP01.

Made Ground was not encountered within exploratory hole S13-WS/DP02 and no soil samples from this exploratory hole were analysed during the soil screening. In addition, given the nature of the construction works being limited to near surface activity (reduced dig and engineered sub-base for surfacing and ramp) shallow depth samples were prioritised

A summary of the soil analyses results together with the applied assessment criteria is presented in Appendix B and summarised below with respect to the considered receptors.

6.1.4 Asbestos

There are no published assessment criteria for assessing the risks from asbestos in soils. Asbestos has been assessed under the precautionary principle whereby the presence of asbestos detected at <0.001% is considered further.

Asbestos screening was undertaken on 4no. samples taken from exploratory holes, TP01, TP02, and S13-WS/DP01 at depths ranging from 0.05 to 0.25m bgl (within Made Ground).

As shown in Appendix B, asbestos was not detected in any soil samples tested.

6.1.5 Soil Analyses Results

Site end users (operational phase)

There were no exceedances when site soils were screened against commercial criteria to assess suitability or reuse with regards to human health.

Construction workers (construction phase) and maintenance workers (operational phase)

Table 7 summarises the recorded exceedances of the applied assessment criteria relevant to construction and maintenance workers (residential without plant uptake).

Table 7: Summary of recorded exceedances on Made Ground (relevant to construction and maintenance workers)

Determinand	Residential with no plant uptake criteria	Identified exceedances
Speciated PAHs		
Benzo(b)fluoranthene	3.9 mg/kg (S4UL LQM 1%)	TP01: 4.0 mg/kg
Benzo(a)pyrene	3.2 mg/kg (S4UL LQM 1%)	TP01: 3.9 mg/kg

6.1.6 Potential Contaminants of Concern – Construction and Maintenance Workers

PAH exceedances of Benzo(b)fluoranthene and Benzo(a)pyrene were locally recorded in the Made Ground sample taken from TP01 at a depth of 0.10-0.20m bgl. No exceedances were identified within the other three soil samples.

No obvious source of PAH contamination was identified within the borehole logs for TP01 during the GI. However, material within the Made Ground associated with the construction of the A369 road, 5m west of TP01 is a potential source for the elevated levels of PAHs identified. The railway land in the east of the site is also a potential source of PAH contamination. However, no PAH contamination was identified within the other samples taken, including those samples taken from S13-WS/DP01 which is situated closest to the railway line (approximately 20m west).

Despite the above recorded concentrations, it is considered that the risk presented to construction workers during construction, and maintenance workers involved in excavations during operation is low. This assessment is based on the application of appropriate health and safety measures including PPE, dust suppression etc. which will mitigate the risk adequately. The contractor should undertake their own assessment to confirm the appropriate level of health and safety measures.

Information regarding the elevated PAHs should be included within the health and safety file for the development.

6.1.7 Groundwater

Groundwater sampling was not undertaken as part of the GI. Given the shallow depth nature of the proposed works and the depth of groundwater strikes during the site investigation it is not considered that contact with groundwater is a plausible pathway.

6.2 Controlled Waters GQRA

6.2.1 Hydrogeological Conceptual Model

Based on the current investigation the following presents a summary of the geology on site.

The existing ground conditions consist of Made Ground/topsoil consisting of higher permeability sands and gravel (to depths of 0.40 to 0.50m bgl). Overlying layers of Alluvium/Tidal Flat Deposits, generally consisting of low permeability clay and silts to depths of up to 6.10m bgl, bedrock consisting of extremely weak sandstone is present below the superficial deposits to an unproven depth.

Made Ground of variable thickness ranging from 0.40 to 0.50m thick was encountered in TP01, TP02 and S13-WS/DP01 but absent in S13-WS/DP02.

Superficial deposits (Alluvium/Tidal Flat Deposits) generally comprising of layers of soft clay and silt were encountered in all exploratory holes, with a proven thickness of 5.50 to 6.10m. A layer of granular Alluvium/Tidal Flats Deposits (sand) was encountered in S13-WS/DP01 at a depth of 3.60 to 4.10m bgl.

Bedrock: Bedrock comprising of extremely weak, light brown, fine to coarse sandstone was encountered in boreholes S13-WS/DP01 and S13-WS/DP02 at depths of 6.00 to 6.10m bgl with an unproven thickness.

As shown in Table 6, groundwater was encountered in TP02, S13-WS/DP01 and S13-WS/DP02 at depths between 5.55 and 6.15m AOD. In TP02 the water rose by 0.90m from 6.15m AOD following the initial strike. Groundwater was not encountered in TP01 on the western side of the site.

The sites do not lie within a Source Protection Zone (SPZ). There are no active surface water abstraction licenses within 1km of the site.

It is anticipated that the first phase of construction of the site will include the excavation of the superficial layers of topsoil/Made Ground which will be replaced by geotextile and gravel for the temporary construction compound.

The second phase of the construction will include construction of the RRAP and access road with a cover of hardstanding.

There is potential for increased infiltration/ migration of contaminants during the first phase when the initial layers of Made Ground/topsoil are removed and replaced by granular fill. However, the risk to the underlying groundwater is considered to be low as the natural ground underlying the site consists mainly of low permeability clays and silts. A layer of granular Alluvium/Tidal Flat deposits (sand) was encountered in S13-WS/DP01 at a depth of 3.60 to 4.10m bgl. However, based on the Network Rail Highways Cross Sections drawing [12] it is not anticipated that excavations will reach further than a depth of 1.25m bgl.

During the second phase of construction, shallow foundations and hardstanding are anticipated to convert much of the site which will break the pathway for the vertical migration of contaminants.

Soil/structure interfaces may create a preferential pathway for leachates related to historic railway infrastructure/Made Ground to migrate to the groundwater within the Redcliffe Sandstone/Mercia Mudstone (Halite and Mudstone) bedrock beneath the sites which are designated Secondary A and Secondary B aquifers respectively.

However, the potential contamination risk from preferential pathways for lateral migration, along higher permeability horizons, and lateral and vertical migration along soil/structure interfaces towards the groundwater is low, given that the development predominantly comprises shallow depth works.

No hydrogeological features are present onsite. An unnamed stream is present on the opposing side of Clanage Road, approximately 30m east of the site, flowing north, and Longmoor brook is present approximately 50m west of site within a culvert. Given the generally low permeability of the soils on site it is not considered that these are at risk from lateral migration of contamination.

During construction the risk to surface water bodies from surface water run off is considered to be low due to the presence of the A369 road and associated drainage to the west which separates the site from the unnamed stream.

Post development, most of the site will comprise hardstanding at surface level, with two drainage features in the north and centre of the site. Thus, minimising any potential for infiltration. With regards to potential risk from surface water run-off, it is anticipated that surface water drainage systems proposed as part of the design will manage this.

The identified PCLs with respect to controlled waters (PCL 5) which have been assessed through GQRA are presented in Table 9.

6.2.2 Assessment Methodology

While the site investigation has typically shown that the site presents a low risk to controlled waters receptors samples of the Made Ground soils were subjected to leachate preparation and assessment to identify if they contained leachable contaminants that may be mobilised.

The following samples have been analysed for the chemical determinands detailed in Section 4.4 in order to determine the potential for contamination to be mobilised from the site soils:

1 No. sample of Made Ground taken from TP01 at a depth of 0.10 to 0.20m bgl.

1 No. sample of Made Ground taken from S13-WS/DP01 at a depth of 0.15 to 0.25m bgl.

In order to assess the identified contamination risks to controlled waters, the results of the chemical analyses undertaken on soil leachate samples have been reviewed and compiled in tables included within Appendix C. The assessment in relation to risks posed to controlled waters is presented below.

Soil quality (leachate) chemical analysis results have been screened against the relevant freshwater Environmental Quality Standards (EQS). Freshwater EQS screening criteria are considered to be the most appropriate for this assessment due to the Secondary A and B aquifers beneath the site not being drinking water resources but potentially acting as pathways to nearby surface water systems.

Several of the FEQS are dependent on hardness data, groundwater analysis was not available, therefore the most conservative values have been adopted.

6.2.3 Soil Leachate Quality Assessment

Table 8 summarises the recorded exceedances of the applied assessment criteria relevant to controlled waters in leachate samples taken from the Made Ground on site.

Table 8: Summary of recorded exceedances in Made Ground (relevant to controlled waters)

Determinand	FEQS criteria	Identified exceedances
Copper (dissolved)	1.0 ug/l	TP01: 37ug/l, S13-WS/DP01: 21ug/l
Zinc (dissolved)	13.2 ug/l	TP01: 34ug/l, S13-WS/DP01: 26ug/l.

6.2.4 Potential Contaminants of Concern – Controlled Waters

The soil leachate assessment identified elevated levels of dissolved copper and zinc within the samples of Made Ground taken from TP01 (0.10-0.20m bgl) and S13-WS/DP01 (0.15-0.25m bgl).

A review of the logs given in Appendix A indicates the presence of anthropogenic materials within the Made Ground including brick cobbles and coal. The logs do not indicate a clear source of the elevated levels of metal identified in the leachate samples aside from the soils being Made Ground within anthropogenic inclusions.

Chemical analysis was not undertaken on samples of natural ground. Therefore, it cannot be concluded whether the elevated levels of dissolved zinc and copper are also present within the natural ground underlying the site.

Despite the exceedances, it is not considered that site soils pose a risk to controlled waters. It is expected that Made Ground soils will be removed and replaced with engineered fill or re-engineered during the works to act as sub-base to hard-surfacing. This hard-surfacing will be provided with surface water drainage and as such there will be limited infiltration on site. On this basis the potential for contaminants to be mobilised from the site soils will be reduced.

6.3 Material Re-use

An assessment of the suitability of the site soils for reuse has been carried out should this be considered as part of the proposed works.

Post construction, the intended end site use consists of a RRAP and a vehicular access point to adjoining land. Therefore, the chemical analysis results for the Made Ground samples tested, have been screened against the guideline values for a commercial end use, to assess their suitability for re-use subject to geotechnical suitability.

There were no exceedances within the samples tested when screened against commercial guideline values. Therefore, with regards to human health, the excavated material is considered suitable for reuse. While testing was not undertaken on natural soils it is generally considered that these would be chemically suitable for re-use but again would require geotechnical analysis to confirm their suitability as engineered fill.

In order to assess the suitability of the excavated soils for re-use with respect to controlled waters the results of the chemical analyses undertaken on soil leachate samples obtained have been reviewed and compiled in tables included within Appendix C of this report. The leachate results have been screened against published EQS and other applicable screening criteria.

Despite the elevated levels of dissolved metals recorded in the 2 No. leachate samples, it is considered that site soils are suitable for reuse on site with regards to controlled waters.

Any materials displaying visual or olfactory evidence of contamination or bulk asbestos are not suitable for re-use without further assessment.

6.4 Revised Conceptual Site Model

The CSM has been revised based on the ground investigation findings and the Relevant Contaminant Linkages (RCLs) have been identified and are summarised in Table 9 below.

Table 9: Revised Conceptual Site Model - RCLs

PCL ID	Potential Source	Potential Pathway	Potential Receptor	Further Actions Required	RCL ID
During Construction					

PCL ID	Potential Source	Potential Pathway	Potential Receptor	Further Actions Required	RCL ID
PCL 1	Contaminated Made Ground across the site related to current and former railway infrastructure. (PAH above the applied assessment criteria recorded in the Made Ground.)	Dermal contact, ingestion, and inhalation of soils and dust.	Site construction workers	Method statement to be prepared by the contractor to set out procedures on how to manage the risks from contaminated Made Ground and required health and safety measures. No further action	-
PCL 2	Potential for contaminated Groundwater (not tested as part of the GI)	Dermal contact with groundwater	Site construction workers	Method statement to be prepared by the contractor to set out procedures on how to manage the risks from contaminated groundwater and required health and safety measures. No further action	-
PCL 5	Contaminated Made Ground across the sites (leachable dissolved zinc and copper identified within Made Ground samples tested)	Preferential pathway for lateral migration along higher permeability horizons and leachate migration of temporarily stockpiled and exposed excavated soils	Groundwater body beneath the site (Mercia Mudstone/ Redcliffe Sandstone Member) Off-site surface water receptors (unnamed stream, 30m west of the site, culverted Longmoor brook, 50m west of the site)	Generally low leachable concentrations of contamination. The assessment has shown generally low risk from leachate in the shallow subsurface due to low permeability geology and hardstanding as part of the proposed development. No further action.	-
During Operation					
PCL 6	Contaminated Made Ground across the site related to current and former land use. (PAH above the applied assessment criteria)	Dermal contact, ingestion, and inhalation of soils and dust	Maintenance workers involved in future excavations	Method statement to be prepared by the contractor to set out procedures on how to manage the risks from contamination (including asbestos), required health and safety measures. Information on the risk included in the site health and safety file. No further action	-

7. Conclusions and Recommendations

The completed human health risk assessment has indicated the following:

No risk was identified to end site users and no specific remedial measures will be required as part of the proposed development.

Locally elevated concentrations of PAH were recorded above the applied assessment criteria for construction and maintenance workers within Made Ground. It is considered that the risk presented to construction workers during construction and maintenance workers involved in excavations during operation is low with the appropriate health and safety measures including PPE which will mitigate the risk adequately.

The contractor should undertake their own assessment to confirm the appropriate level of health and safety measures.

The completed controlled waters risk assessment has indicated the following:

No significant contamination was identified, and it is considered that the recorded leachable dissolved metal concentrations within the Made Ground do not pose a risk to controlled waters due to the generally low permeability of the Alluvium/Tidal Flat Deposits (clays and silts) underlying the Made Ground.

Overall, it is considered that the proposed development will result in the betterment of the site conditions due to the addition of a layer of hardstanding and site drainage. Therefore, the risk to controlled waters from leaching and subsequent lateral/vertical migration of contamination is low.

With regards to suitability of re-use of excavated soils as part of the proposed development, the completed assessments have indicated the following:

Made Ground soil samples screened against commercial guidance values did not display any exceedances. Due to the low sensitivity of the site, and lack of exceedances, it is considered that reuse of materials is suitable for the site with regards to human health.

For natural soils it is not anticipated that contamination will be present and as such these should be considered suitable for re-use subject to being geotechnically suitable.

The Made Ground soils encountered across the site displayed elevated levels of dissolved heavy metals (copper and zinc) that exceeded the applied screening criteria with respect to controlled waters. However, due to reduction in potential infiltration on the site by surfacing and site drainage and the low permeability of underlying natural ground, it is considered that site soils are suitable for re-use on site with respect to controlled waters.

Overall, excavated soils are considered suitable for re-use on site, subject to geotechnical suitability.

Any materials displaying visual or olfactory evidence of contamination or bulk asbestos are not suitable for re-use without further assessment.

In summary the investigations have confirmed a low risk to human health and controlled waters. A method statement should be prepared by the contractor to set out procedures on how to manage the risks from PAHs identified and required health and safety measures. On the above basis, no further assessment is considered to be necessary.

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Drawings (Included in Factual Report)

Drawing 1 – Location plan of exploratory holes

Photographs (provided as a separate document)

Photograph 1 - TP01 Site Photo, 1.20m Depth

Appendix A – Factual Report (GEL) (provided as a separate document)

Appendix B- Human Health Risk Assessment Screening Tables (provided as a separate document)

Appendix C - Controlled Waters Risk Assessment Screening Tables (provided as a separate document)