Contaminated Land Review

Tees Valley Bottom Ash Facility
Grangetown Prairie, Dorman Point
Prepared on behalf of Viridor Waste Limited
March 2023

Intended for
Viridor Waste Limited

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Report

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TEES VALLEY BOTTOM ASH (BA) FACILITY GRANGETOWN PRAIRIE, DORMAN POINT CONTAMINATED LAND REVIEW

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TEES VALLEY BOTTOM ASH (BA) FACILITY
CONTAMINATED LAND REVIEW

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APPENDICES

1. INTRODUCTION

1.1 Background

Ramboll UK Limited ('Ramboll') has been commissioned by Viridor Waste Limited (hereinafter referred to as the 'Applicant') to prepare a Contaminated Land Review (hereafter referred to as the 'Review) for the proposed development of a Bottom Ash (BA) Facility on site at Grangetown Prairie near Tees Valley (hereafter referred to as the 'site'). The site is located within the administrative authority of Redcar and Cleveland Borough Council (RCBC).

The development proposal comprises a BA Facility (hereinafter referred to as the 'proposed development') for which the Applicant intends to submit a planning application for outline planning permission (hereafter referred to as the 'application').

1.2 Objective and Scope of Works

Historical desk-based assessments and intrusive ground investigations with respect to land contamination have been undertaken across Grangetown Prairie, which included investigation within the boundary of the site. These investigations were undertaken for future redevelopment of Grangetown Prairie for a generic commercial land use. As such the historical investigations undertaken within the site are not necessarily specific to the nature and layout of the proposed development of the site as a BA facility, albeit the owners and remediators are aware of the future use.

The objectives of this assessment are therefore to demonstrate to the local planning authority, RCBC, that:

- The investigation works completed to date provide sufficient appropriate information to characterise the site; and
- The remediation works carried out across Grangetown Prairie as part of the wider scheme are appropriate and fit for purpose for the proposed redevelopment of the site as a BA Facility.

In the event that insufficient appropriate information is found to exist, or that land contamination risks to the proposed development are not sufficiently mitigated by the remediation works, then recommendations for further investigation and/or remediation works will be provided.

1.2.2 Scope

Given the work completed to date within Grangetown Prairie and the site, the scope of works is to provide a review of the information that is applicable to the BA Facility site to inform the outline planning permission being sought for the BA Facility. Further detail of the scope of this report is as follows:

- Review existing contaminated land desk-based assessments for Grangetown Prairie and the BA Facility site. Review existing Conceptual Site Model (CSM) and risk assessments within the desk-based assessments and confirm that they are relevant to the site, and identify sources, pathways and receptors specifically relevant to the site;
- Review the historical ground investigation factual and interpretative reports for Grangetown Prairie and the site to confirm the:
  - Scope of investigation completed within the site boundary;
  - Scope of investigation addressed all potentially significant risks identified within the site-specific CSM and risk assessments; and
  - The geographical and vertical extent of the investigation within the site boundary is appropriate to the proposed BA development.
- Review the remediation options appraisal and strategy for Grangetown Prairie to:
  - Assess the relevance of remediation activities which have been completed within the site boundary to the proposed BA Facility development; and

  - Identify any risks that remain unaddressed and what future actions need to be completed to address those risks; and
- Review remediation monitoring records and validation documents made available at the time of assessment in order to support the previous actions.

The assessment contained within this report has been completed in compliance with the current legislative framework, details of which together with the background to assessment methodologies are provided in Appendix A.

1.3 Limitations and Constraints

In preparation of the report and performance of any other services, Ramboll has relied upon publicly available information, information provided by the client and information provided by third parties. Accordingly, the conclusions in this report are valid only to the extent that the information provided to Ramboll was accurate, complete and available to Ramboll within the reporting schedule.

The key sources of information used to prepare this report are provided as footnotes within the document. Ramboll cannot accept liability for the accuracy or otherwise of any information derived from third party sources.

Ramboll's services are not intended as legal advice, nor an exhaustive review of site conditions and/or compliance. This report is intended solely for the use and benefit of the client for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts any duty to any third party, unless formally agreed by Ramboll through that party entering into, at Ramboll's sole discretion, a written reliance agreement.

Ramboll did not undertake site attendance for ground contamination or collect samples of any environmental media or obtain verification data for remediation works undertaken on site to date (beyond reviewing verification data provided to Ramboll by the client or third parties). Ramboll cannot rule out the existence of conditions, including, but not limited to, contamination not identified and defined by the data and information available to and/or obtained by Ramboll. Specifically, this assessment must not be considered as an asbestos survey (whether in built structures, waste, soils, etc), even though the subject of asbestos-containing materials may have been discussed in the report.

This report has been prepared with respect to contaminated land only. Geotechnical assessment of ground investigation data was outside of agreed scope of service for this report.

At the time of writing, there is no detailed information regarding the layout or detailed design of the BA Facility, however it is expected that piled foundations may be required. It is noted within this report that the assessments completed to date on the site do not consider these and that should deep structures or piles be required as part of the final development design, then further assessment may be required.

2. SITE DETAILS

2.1 Site Context

The proposed BA Facility site lies within the area known as Grangetown Prairie, owned by the South Tees Development Corporation (STDC). The site forms part of 1,800 ha of land previously occupied by heavy industry and infrastructure that is subject to STDC's Regeneration Master Plan.

The proposed BA Facility site was formerly used for the production of iron and steel. Following the closure of the steel works and cessation of industrial activities, the building complex was cleared in the 1980's and the site is now vacant.

The site lies within the southwest corner of the STDC regeneration area, within the Grangetown Prairie Zone. It is located approximately 1.5 km from the River Tees to the north, around 6.5 km to the northeast of Middlesbrough and approximately 5 km south west of Redcar town centre. It is also located immediately adjacent to the eastern boundary of the proposed Tees Valley ERF site.

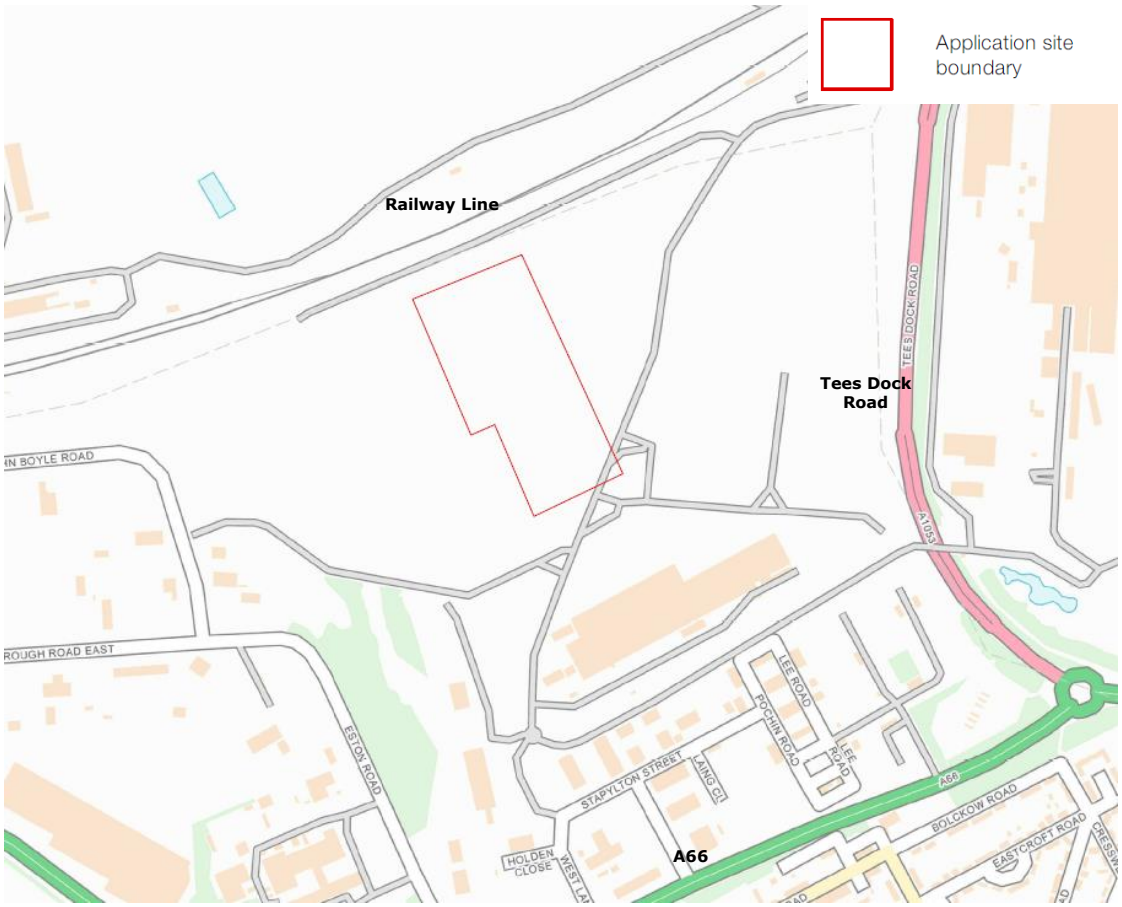


Figure 2.1: Site Location.

The proposed BA Facility site covers an area of around 4.74 ha, that is rectangular in shape and situated to the east of John Boyle Road (with the ERF site in between). To the east of the site lies Tees Dock Road, to the south runs the A66 and to the north is a railway line. Whilst the site does not currently have direct access to the public highway, it is expected that STDC will provide new road infrastructure to serve the site in the near future, as part of the Regeneration Master Plan.

A high voltage overhead cable and associated pylons are located adjacent to the northern site boundary running parallel to the site boundary. The Tees Valley Railway (TVR) Line is located immediately beyond this, running approximately parallel to the northern site boundary.

From a recent site walkover (2023), the majority of the site is being used as stockpiling, with just a small strip of remnant vegetation along the side of the haul road.

2.2 The Proposed Development

The proposed development consists of a BA facility, including a covered conveyor, a BA hall, six storage bays and ancillary buildings.

The proposed development is anticipated to transfer 100% of the BA (approximately 100,000 tonnes per annum (tpa)) produced from the Tees Valley Energy Recovery Facility (ERF), which is located directly adjacent (west) of the BA site. The process will involve the transfer, by covered conveyor, of the raw BA from the ERF to the raw BA hall at the proposed BA Facility site, or by covered vehicles via an internal link, or by road.

In addition to the 100,000 tpa from the Tees Valley ERF, the proposed new BA Facility would be designed to accommodate a further up to 80,000 tpa from third party sources. BA from third party sites would be delivered to the BA hall by road. The BA will be placed into one of six storage bays for maturation over a 14-56 day period.

3. PHASE 1 SITE ASSESSMENT

3.1 Source Documentation

The reports listed in Table 3.1 include Phase 1 assessments (or elements of Phase 1 Assessments) of the wider Grangetown Prairie that have been referred to in preparation of Section 3 of this report. Ramboll has not been supplied with any additional reports that refers specifically to the BA Facility site.

Table 3-1: Phase 1 Assessments (or Reports with Elements of Phase 1 Assessments)

Report	Relevant Planning Application
JBA Consulting (2019). Volume 1: Environmental Statement (Chapter 8 - Ground Conditions), Energy Recovery Facility, Grangetown Prairie, Redcar, The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, Ref 2019s0951[1]	R/2019/0427/FFM
Wood (2019). Outline Remediation Strategy, Former Steelworks Land, South Tees, Ref 41825-WOOD-XX-XX-RP-OC-0001-SO-P01[2]	R/2020/0318/FFM
Arcadis (2020). Phase II Environmental Site Assessment, Grangetown Prairie Area, Former Steelworks, Redcar, Ref 10035117-AUK-XX-XX-RP-ZZ-0062-01-Prairie_ESA[3]	R/2020/0318/FFM
Stantec (2020). Phase 1 Geoenvironmental and Geotechnical Desktop Study, Tees Valley ERF, Grangetown Prairie, Redcar, TS10 5QW, Ref RT-NN-2725-5QW[4]	R/2019/0767/OOM
Arcadis (2020). Detailed Conceptual Site Model Review and Risk Assessment, Grangetown Prairie Area, Former Steelworks, Redcar, Ref 10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment[5].	R/2020/0318/FFM
Arcadis (2020). Phase II Environmental Site Assessment - Addendum, Grangetown Prairie Area, Former Steelworks, Redcar, Ref 10035117-AUK-XX-XX-RP-ZZ-0117-01-Prairie_ESA_Addendum[6]	R/2020/0318/FFM

3.2 Site History

A summary of historical uses at the site and in the immediate vicinity (within 100 m of the site, or 250 m for areas of infilled land) has been adapted from the Stantec desk study[4] and presented in Table 3-2. Where possible, additional detail has been supplemented from the site history of Grangetown Prairie detailed by the Wood Outline Remediation Strategy[2].

[1] JBA Consulting (2019). Volume 1: Environmental Statement (Chapter 8 - Ground Conditions), Energy Recovery Facility, Grangetown Prairie, Redcar, The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, ref. 2019s0951

[2] Wood (2019). Outline Remediation Strategy, Former Steelworks Land, South Tees, ref. 41825-WOOD-XX-XX-RP-OC-0001-SO-P01

[3] Arcadis (2020). Phase II Environmental Site Assessment, Grangetown Prairie Area, Former Steelworks, Redcar, ref. 10035117-AUK-XX-XX-RP-ZZ-0062-01-Prairie_ESA

[4] Stantec (2020). Phase 1 Geoenvironmental and Geotechnical Desktop Study, Tees Valley ERD, Grangetown Prairie, Redcar, TS10 5QF, ref. RT-NN-2725-5QW

[5] Arcadis (2020). Detailed Conceptual Site Model Review and Risk Assessment, Grangetown Prairie Area, Former Steelworks, Redcar, ref. 10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment

[6] Arcadis (2020). Phase II Environmental Site Assessment - Addendum, Grangetown Prairie Area, Former Steelworks, Redcar, ref. 10035117-AUK-XX-XX-RP-ZZ-0117-01-Prairie_ESA_Addendum

Table 3-2: Summary of Site History

Date	On Site	Off Site
1857	The site is identified as 'The Pastures' and seems to be primarily agricultural land.	The Tees Valley Railway (TVR) line located approximately 50 m north of site, with undeveloped land 'prone to flooding' beyond this. Land to east and south is undeveloped. Eston Iron Works with associated several small buildings and a row of circular tanks is present to the west of the site, with a railway line beyond this, running north-south.
1895-1915	Site significantly developed as part of Cleveland Steel Works. The site itself houses one main building and smaller buildings / storage rooms leading away from this. There are railway sidings leading to buildings and smaller process/storage buildings and tanks occupying the rest of site. Tank noted in the north eastern corner of the site in 1915.	The TVR line to north expanded to include multiple tracks. Land to north of TVR line occupied by extensive slag heaps. Land to east and south is railway sidings and a roadway, but still undeveloped in most areas. Land to the west is Cleveland Steelworks land that has also undergone development. Three 20 m blast furnaces, four Bessemer Conversion Vessels, 'Bessemer furnaces', coke ovens, steel mills and associated plant were reported to be located to the west of the site. There is a well reported to be located in the steel works to the west of the site. The land further west is railway sidings and Cleveland Iron works, and a gas works is noted. Station Road located approximately 100 m to the east of the site. Water body (anticipated to be part of Holme Beck – distance from site not noted) noted by Wood in northwest of Grangetown Prairie and Knitting Wife Beck present to the east of the site in Grangetown Prairie.
1919-1931	Further expansion of the steelworks is shown and the buildings now cover more area in the north and south of the site. Further expansion of the railway sidings now showing to run approximately east – west direction, running from the east of the site. Travelling cranes now situated in the centre and to the east of the site from 1929.	Land to north of TVR line forms part of Basic Slag Works located 150 m north of site. Further development of the steel works to the east and south of the site including a cooling pond and pumping station. Development beyond the Knittingwife Beck now includes Grangetown Power station and old clay pits. West of the site is the steelworks. By 1915, this part of the steel works further is developed with more railway sidings within east and southeast of site, further storage tanks in centre-west extending south and a travelling crane located towards the west. Well to the west of the site no longer recorded.
1938-1952	Main steel works building expanded southwards into east of the site. Further travelling cranes shown in centre, northeast and north of the site. Engine house (location not specified), water cooling tower (in south of site) and chimneys (in centre of site) constructed on the site at this time.	Land surrounding site has undergone further general industrial development. Travelling cranes present approximately 90 m to 100 m east of site and adjacent to west of the site. Oxygen tanks shown approximately 40 m to south. Knittingwife Beck no longer shown to the east of the site.
1952-1955	Electrical substation located on the eastern boundary of the site, with the travelling cranes beyond.	Further development of the steel works to the east of the site.

Date	On Site	Off Site
	Pipe line noted to cross the southern boundary of the site.	
1958 - 1978	Pipeline no longer crossing the site. From 1971, tanks noted on the western boundary of the site.	No significant changes other than fewer railway sidings.
1990 - 1994	Buildings no longer present on site, with the exception of three smaller buildings to the south.	Buildings to the west of the site have also been decommissioned. Fewer railway sidings. Slag / refuse heaps noted to be present more than 100 m north of site, beyond TVR line. Buildings still exist to east and south of the site.
1999-2006	No buildings are shown on site. Only the road shown to cross the south eastern corner of the site. 1999 aerial image shows the land is being used for the storage of lengths of steel.	1999 aerial image shows the land directly east and west of the site is being used for the storage of lengths of steel. By 2006, there are no buildings shown to the west of the site. The railway is still in place to the north of the site, with slag heap beyond. Buildings to the south and east of the site still remain. Knittingwife Beck shown approximately 100 m to the southeast of the site.
2020	No significant change	Building to the east of the site has been decommissioned.
2021	The site has been subjected to remedial earthworks (as detailed in Section 4and 5 of this report).	The site has been subjected to remedial earthworks (as detailed in Section 4and 5 of this report).

A plan of potential areas of concern (PAOC) is included in the Arcadis Phase II Environmental Site Assessment[3], and presented in Figure 3.1 below. The BA site's PAOC includes its historical use as Cleveland Steelworks, and the associated infrastructure, including railway sidings and electrical substations. The site history detailed in Table 3-2 and Figure 3.1 demonstrates that the site and surrounding area has been heavily industrialised historically, with multiple potential contaminant sources occupying the entire footprint of the site.

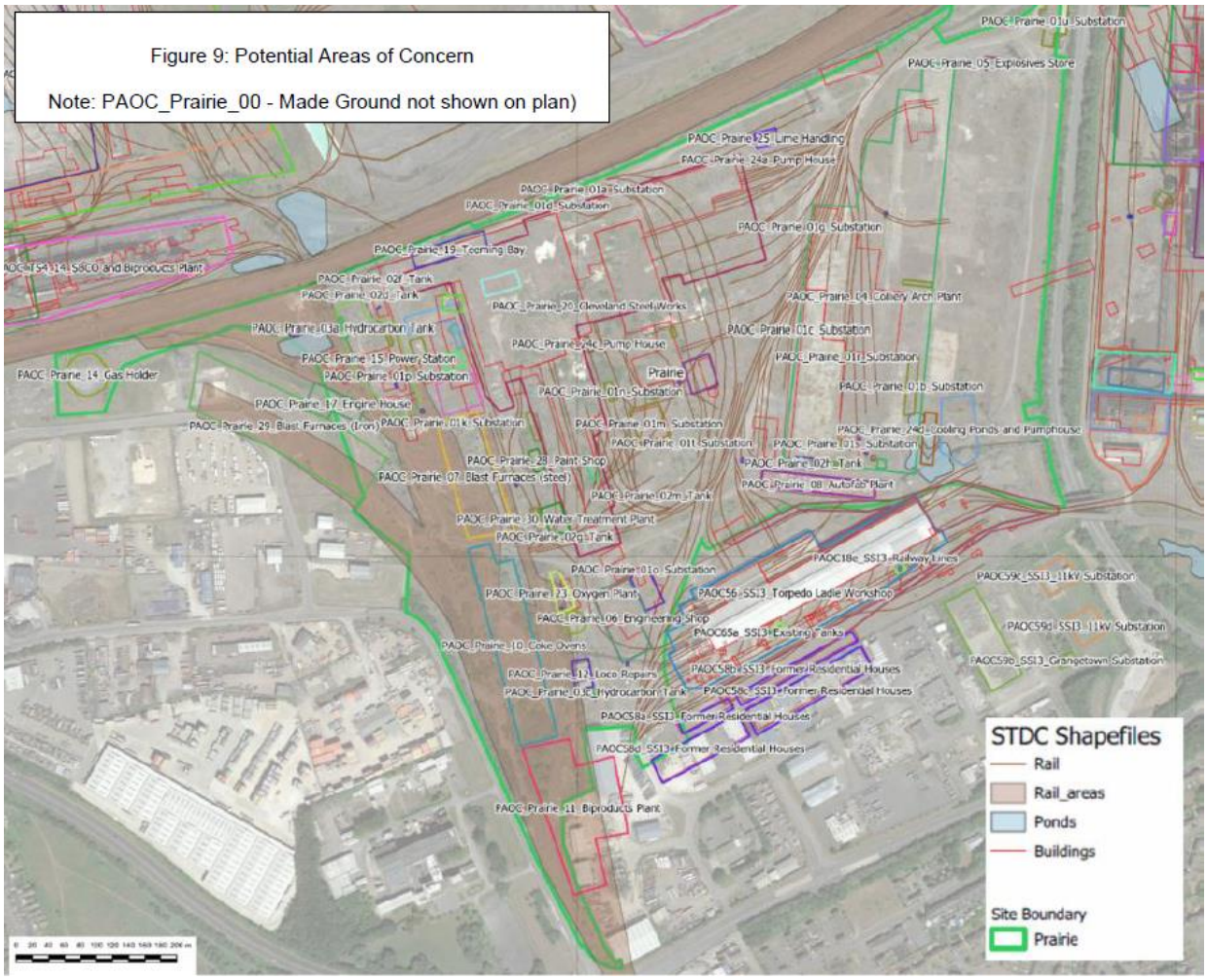


Figure 3.1: Potential Areas of Concern (PAOC) (adapted from Arcadis (2020))

3.2.1 Unexploded Ordnance (UXO)

A Preliminary Unexploded Ordnance (UXO) threat assessment was undertaken by Alpha Associates on behalf of Stantec7 on the site directly to the west of the BA site. The UXO risk at this neighbouring site was assessed as 'Likely'. A preliminary UXO threat assessment has not been undertaken at the BA site, therefore a UXO Threat and Risk Assessment is recommended to be undertaken prior to intrusive ground investigation at the BA site.

3.2.2 Geology and Hydrogeology

Made Ground is present across the site and surrounding area, typically comprising concrete overlying blast furnace slag from ground level to depths of up to approximately 5.55 metres below ground level (mbgl). The Made Ground at the site is underlain by superficial deposits comprising Glaciolacustrine Deposits (clay and silt).

Tidal flat deposits (mud flat and sand flat deposits comprising clay and occasional peat, silt and sand) are noted to be located 120 m north of the site, and may have the potential to encroach onto the site. Both the glaciolacustrine deposits and tidal flat deposits are noted to be underlain by glacial till (stiff clay with varying proportions of silty sand, gravel, cobbles and boulders).

Bedrock beneath the site comprises the Mercia Mudstone Group (red and occasionally green mudstones and subordinate siltstones with thick halite-bearing units in some basinal units, and sandstones also present) and the Penarth Group (black mudstones with subordinate limestones and sandstones) in the south of the site only. Approximately 100 m to the south of the site, the Redcar Mudstone Group subcrop

is noted, and as such may have the potential to encroach onto the site. The Sherwood Sandstone Group is located beneath the mudstones at depth.

The Environment Agency (EA) aquifer classifications of the strata detailed above are summarised in Table 3-3.

Table 3-3: Summary of EA Aquifer Classifications

Strata	Typical Thickness (m)*	Aquifer	Aquifer Definition
Made Ground	0.6 to 8.0	Not classified	N/A
Glaciolacustrine Deposits	0.8 to 10.5	Unproductive Strata	Strata with low permeability that have negligible significance for water supply and/or river base flow.
Tidal Flat Deposits	0.7 to 4.45**	Secondary (Undifferentiated)	Assigned where it is not possible to attribute either Secondary A or Secondary B aquifer status due to variable characteristics of rock type.
Glacial Till	0.55 to 14.6	Unproductive Strata	As Glaciolacustrine Deposits.
Redcar Mudstone Group	Up to 280 approximately	Secondary (Undifferentiated)	As Tidal Flat Deposits.
Penarth Group	0 to 12	Secondary B	Lower permeability strata which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.
Mercia Mudstone Group	Up to 200 approximately	Secondary B	As Penarth Group.
Sherwood Sandstone **Group**	Up to 220 m approximately	Principal	Rock layers with high intergranular or fracture permeability, usually providing a high level of water storage. May support water supply and/or river base flow on a strategic scale.

Notes:

* Thickness of Made Ground and superficial deposits based on borehole logs obtained from historical ground investigation locations on site. Thickness of bedrock strata obtained from BGS geological mapping sheet 33[7].

** Based on tentative identification of River Terrace Deposits from descriptions in historical borehole logs[1].

Arcadis[6] noted that groundwater elevation (over three monitoring rounds) in the superficial deposits was in the range of 4.77 – 8.51 m above Ordnance Datum (AOD) and was measured at 2.30 – 6.65 m AOD in the bedrock. The groundwater flow direction within the superficial deposits and the bedrock of the wider Grangetown Prairie site has been towards the northeast. It is noted that the inferred flow directions are based on limited groundwater elevation data from a limited number of wells given the size of the Grangetown Prairie site. The River Tees is located to the north of the site and runs eastwards. Arcadis therefore deemed it likely that the inferred groundwater flow directions are in line with the regional hydrogeology.

Arcadis[6] noted there were regular cycles observed during the tidal monitoring that was undertaken, however there is not enough data to determine conclusively that the groundwater is tidally influenced.

[7] BGS (1987). Stockton Solid and Drift Geology, British Geological Survey 1:50,000 Series, Sheet 33.

There are no groundwater Source Protection Zones recorded within 1 km of the site. There are no recorded abstractions from groundwater within 1 km of the site. The site is not located within a Drinking Water Safeguard Zone.

Communication from the EA to RCBC dated 20 August 2020 (Ref NA/2020/115071/01-L01) noted that while the site is considered a lower environmental sensitivity area with respect to groundwater, the EA did not consider the pollution risk to controlled waters underlying Grangetown Prairie to be acceptable or that it should not be considered further without appropriate investigation and assessment. At the time of this communication, the following documents had been submitted to RCBC in support of the Grangetown Prairie planning application (R/2020/0318/FFM):

- Arcadis (2020) Phase 2 Environmental Site Assessment (25 June 2020)[3];
- Arcadis (2020) Remedial Options Appraisal and Strategy (25 June 2020)[17]; and
- Arcadis (2020) Phase 2 Environmental Site Assessment – Addendum (19 August 2020)[6].

Given the date of the reserved matters application, it is considered unlikely that the EA were aware of assessment of the groundwater environment undertaken as part of the Phase 2 Environmental Site Assessment – Addendum. These reports are detailed further in Section 4 and Section 5 of this report.

3.2.3 Hydrology

The nearest surface water bodies to the site are several small surface water bodies within or close to the site (ponds, lagoons, drainage channels and culverts). Within the Stantec desk study that is specific to the ERF site[4] it is noted that these are primarily regarded as ephemeral, although wetland species such as the common reed are recorded and likely to be the result of localised poor drainage.

Minor watercourses in the vicinity of the site include the former course of Holme Beck to the west of the site and Knitting Wife Beck 380 m to the east of the site. The nearest non-culverted portion of Holme Beck is located approximately 320 m south of the site, with the culverted portion running approximately parallel to the western site boundary immediately west of the site. The stream is culverted along the entire length within and immediately adjacent to the site. The culverted portion of Holme Beck is diverted to run north of the site boundary before draining into the Cleveland and Lackenby Channels approximately 680 m northeast of the site. Knitting Wife Beck also drains to the Cleveland and Lackenby Channels, which in turn drain to the River Tees. Holme Beck and Knitting Wife Beck were both noted by Stantec to be of very low sensitivity as they are not classified under the Water Framework Directive (WFD) and have limited ecological potential. Being culverted for extensive stretches also reduces the potential for ingress of contamination from surface and near-surface sources of contamination.

The River Tees is located approximately 1.6 km northwest of the site, and is classified by the EA as being of 'Poor' ecological status, chemical status and overall status under the WFD classification scheme as of 2019[4].

The EA flood risk maps for planning show the site and surrounding area to be within a Flood Zone 1, which is defined as land having a less than 1 in 1,000 annual probability of river and sea flooding[4].

3.2.4 Ecology

Grangetown Prairie and the site were noted within the Wood Outline Remediation Strategy[2] to be classified as a Biodiversity Interest Area for varying biodiversity (dunes, reptiles, calcareous grassland, invertebrates).

It is noted within the Arcadis Remedial Options Appraisal and Strategy[17] for Grangetown Prairie that Small-Leaved Cotoneaster and Sea Buckthorn (both considered to be non-native invasive species) were previously identified on site. Small-Leaved Cotoneaster is noted to be on Schedule 9 of the Wildlife and Countryside Act 1981 and is illegal to spread or replant. The locations of these species on Grangetown Prairie were not noted by Arcadis, and as such these species may also have been present on the site.

An extended Phase 1 habitat survey of the site was undertaken by Ramboll on 14th February 2022. From the site walkover, the majority of the site currently constitutes bare ground/stockpiles following remediation works on the site and on adjacent land. Following a validation survey in January 2023, also undertaken by Ramboll, it was confirmed that the nature of the site remains unchanged, with the majority of the site being used as stockpiling, with just a small strip of remnant vegetation along the side of the haul road. The survey confirmed that the site is of nature conservation importance at up to site level.

3.2.5 Environmental Sensitivity and Vulnerability

The site sits within the SSSI Impact Risk Zone for Teesmouth and Cleveland Coast SSSI, Ramsar and SAC which is located approximately 1.6 km northwest of the site at its closest point. No direct impacts on the SSSI are anticipated.

3.3 Industrial Land Uses and Activities (pre-remediation)

A summary of information on potential sources of contamination at the wider Grangetown site (i.e. the site and surrounding area), obtained from an Envirocheck report within the Stantec Desk Study[4] has been adapted for the BA site and is presented as Table 3-4. Where possible, additional detail has also been supplemented from the regulatory database information for Grangetown Prairie detailed by the Wood Outline Remediation Strategy[2].

Table 3-4: Summary of Industrial Land Uses and Activities

Activity	On Site	0 m-250 m	Details
Authorised and Historical Landfill	0	3	The closest landfill to the site (as detailed by Stantec) is located 96 m northwest of site. The landfill is operated by Sahaviriya Steel Industries UK under permit EPR/RP3434HP with a capacity of >25,000T excluding inert waste. Other landfills within 250 m are located approximately 150 m northwest and 160 m northwest. Details of waste types accepted are not provided.
Waste Transfer / Treatment / Disposal Facilities	1	1	Records detailed by Wood include a permit for 'SSI' for storage of furnace-ready scrap for recovery. The permit was issued in December 2014 and is listed as revoked. Scot Bros Recycling Ltd held a permit for a household, commercial and industrial waste transfer station issued in December 1996. Wood did not specify the locations of each feature. It is anticipated that storage of furnace ready scrap was located on site, and the waste transfer station was located outside of Grangetown Prairie.
Current Industrial Features	14	99	Numbers of on-site and off-site records noted by Wood relate to Grangetown Prairie, and as such number of records relating directly to site are likely lower than reported. Records relate to Teesside Works, tanks, pylons, pipelines and electricity substations. These features were historically present on the site with the exception of the pylons, which are located adjacent to the northern site boundary.
Historically potentially contaminative land uses.	154	222	Numbers of on-site and off-site records noted by Wood relate to Grangetown Prairie, and as such number of records relating directly to site are likely lower than reported. Records relate to iron and steel works including pits, tanks, heaps, railways, cuttings and gasworks. These features were historically present on the site with the exception of the gasworks, which was located to the west of the site (beyond the adjoining ERF site).
Tanks	323	456	Numbers of on-site and off-site records noted by Wood relate to Grangetown Prairie, and as such number of records relating directly to site are likely lower than reported. Records relate to tanks and gasworks. A large number of tanks were historically present on the site; however, the gasworks was located to the west of the site (beyond the adjoining ERF site).
Mineral extraction	1	0	Wood notes the presence of abandoned brine wells on Grangetown Prairie. This may relate to the historical well located on the site (1895 – 1915 approximately).

3.3.1 Coal Mining

The site and surrounding land within 1 km are not located in an area considered by the Coal Authority likely to be affected by coal mining or mining instability.

3.4 Conceptual Site Model

The Phase 1 information obtained from the Stantec[4], Arcadis[3] and Wood[2] reports, and outlined above, has been collated and evaluated to develop a Conceptual Site Model (CSM) specific to the site.

3.4.1 Potential Sources

The potential contaminant sources on the site and immediate vicinity are summarised in Table 3-5.

Table 3-5: Summary of Potential Sources (Phase 1)

Source	Key Potential Contaminants
Former steel works (on-site and off-site)	Metals, inorganics (fluoride, sulphates, phosphates), total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), phenols, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), benzene, toluene, ethylbenzene and xylenes (BTEX), ground gases.
Rail lines and sidings (on-site and off-site)	Metals, ACMs, TPH, PAH, phenols, VOCs, SVOCs, herbicides.
Historical pipelines (on-site and off-site)	ACMs, TPH, PAH.
Blast furnaces, coke ovens, steel mills (on-site and off-site)	TPH, PAH, VOCs, SVOCs.
Engine house (on-site and off-site)	Metals, ACMs, TPH, PAH, phenols, VOCs, SVOCs.
Paint Shop (off-site)	Metals, VOCs, BTEX, herbicides
Chimneys (on-site)	TPH, PAH, VOCs, SVOCs.
Tanks / tank farm (on-site)	TPH, PAH, VOCs, SVOCs.
Electricity Substations (on-site)	Polychlorinated biphenyls (PCBs).
Former Iron Works (on-site and off-site)	Minerals (oxides of calcium, silicone, phosphorus and sulphur), metals (including iron ore), inorganics (fluoride, sulphates, phosphates), TPH, PAH, phenols, VOCs, SVOCs, BTEX, ACMs and ground gases.
Made Ground / potentially infilled ground / slag heaps (on-site and off-site)	Metals, inorganics (fluoride, sulphates, phosphates), TPH, PAH, phenols, VOCs, SVOCs, BTEX, ACMs and ground gases.
Gasworks (off-site)	Cyanide, metals, PAHs, coal tars, ammonium sulphate, ammonium cyanide, thiocyanate, VOCs, SVOCs and ground gases.
Fire station (Off-site)	Perfluorooctanoic acid (PFOA), Perfluorooctanesulfonic acid (PFOS).

3.4.2 Potential Receptors

The specific receptors that could potentially be affected by the key potential contaminants listed in Table 3.5 are summarised in Table 3.6.

Table 3-6: Summary of Potential Receptors (Phase 1)

Receptor	Comments
On-site	
Future site users (Commercial/industrial)	Future staff of and visitors to the proposed BA facility, including below ground level (if applicable).
Construction/maintenance workers	Workers involved in construction of the proposed BA Facility and future maintenance workers, including below ground level (if applicable)
Buildings and structures	Building materials used below ground level (e.g. foundations, drainage structures, water supply pipes).
Soft landscaping and sustainable drainage (SuDS) features (localised permeable surfaces)	Areas of soft landscaping and sustainable drainage solutions forming part of the external spaces of the development (if applicable).
Groundwater receptors (Secondary B / Undifferentiated Aquifers)	Bedrock of limited permeability underlying Made Ground at the site. These comprise the Mercia Mudstone Group (Secondary B Aquifer) and potentially the Penarth Group (Secondary Undifferentiated Aquifer) and Redcar Mudstone Group (Secondary B Aquifer).
Groundwater receptors (Principal Aquifer)	The Sherwood Sandstone Group (Principal Aquifer), located at depth beneath the site.
Off-site	
Surface Water Receptors (Holme Beck, Knitting Wife Beck)	Small, unclassified surface water receptors located in Grangetown Prairie, located approximately 320 m south of the site and 280 m east of the site respectively and draining to the River Tees via the Cleveland and Lackenby Channels. Holme Beck is culverted from approximately 420 m southwest of the site, passing immediately west of the site and diverted to follow the northern site boundary until entering the Cleveland and Lackenby Channels.
Surface water receptors (River Tees)	The River Tees, located 1.6 km northwest of the site at its closest point. Classified as 'Poor' ecological status, chemical status and overall status. Designated as a SSSI and SPA.

3.4.3 Potential Pathways

In order for potential contaminants to pose a risk to the identified receptors, there must be a viable pathway for the contaminant. The potential pathways relevant to the site are summarised in Table 3.7.

Table 3-7: Summary of Potential Pathways (Phase 1)

Receptor	Key Potential Pathways	Comments
Human health	Direct contact with contaminated soils or groundwater	**Construction**: Construction workers have the potential to come into contact with contaminants in soil and groundwater during site enabling works and construction activities.
		Operation (including maintenance): The pathway to future site users is expected to be minimised by the presence of concrete foundations and hardstanding beneath the proposed buildings, access roads and car parking space. There may be some limited risk of exposure from the communal soft landscaping in parts of the site. Maintenance workers may have the potential to come into contact with contaminants in soil and groundwater if required to break ground during future maintenance works.
Human health	Inhalation and ingestion of dusts/fibres and inhalation of gas and vapours	**Construction**: Construction workers and adjacent site users may be subject to accidental ingestion and inhalation of dust, fibres, vapour and ground gases.
		Operation (including maintenance): The pathway to future site users is expected to be minimised by the presence of concrete foundations and hardstanding beneath the proposed buildings and car parking spaces. Maintenance workers may be subject to accidental ingestion and inhalation of dust, fibres, vapour and ground gases. Risk is anticipated to be low as maintenance works will be at much smaller scale than construction works and whole site will not be exposed to atmosphere.
Human health	Accumulation of asphyxiating/explosive gases in confined spaces	**Construction**: Construction workers may be subject to accidental inhalation of accumulated vapour and ground gases when working in confined spaces such as excavations.
		Operation (including maintenance): Enclosed spaces on the site are anticipated to be divided into above-ground space within the BA building and above-ground office spaces. It is unknown whether there will be below ground structures at this point. Above-ground space within the BA building is anticipated to be spacious and well-ventilated. Above-ground office spaces may be smaller and less well ventilated. If there are below ground spaces, a risk of accumulation of asphyxiating/explosive ground gases and vapours may be present, though the structure of any below ground structures (e.g. concrete walls and base) will provide protection against ingress of ground gases. Future site users and maintenance workers working in office spaces and other enclosed spaces such as utility spaces may therefore be subject to accidental inhalation of accumulated vapour and ground gases.

Receptor	Key Potential Pathways	Comments
Human health	Infiltration of organic contaminants into drinking water supply pipes	**Operation (including maintenance):** Made Ground at the site is anticipated to contain organic contaminants such as hydrocarbons which may have the potential to impact water supply pipes placed in the affected ground. Future site users may be subject to ingestion of contaminants infiltrating into drinking water.
Buildings and structures (construction materials)	Damage to building materials or services through direct contact with contaminated soil/groundwater	**Construction (short term) and Operation (long term):** Aggressive ground conditions or organic contaminants such as hydrocarbons may affect subsurface construction materials such as foundations or drainage structures. Services may be affected by direct contact with aggressive soils or influx of contaminated groundwater.
Plants	Uptake of phytotoxic contaminants	**Operation (including maintenance):** Plants in areas of soft landscaping may have the potential to be impacted by phytotoxic contaminants in soil should they be planted in or at a height above such soils where the root zone could intercept them or water be taken up by the plants.
Secondary B and Secondary (Undifferentiated) aquifers	Vertical migration of contaminants via preferential pathways	**Existing Site Conditions:** Made Ground at the site is underlain by Glaciolacustrine Deposits and Glacial Till (Unproductive Strata) which are in turn underlain by the Mercia Mudstone Group (Secondary B Aquifer) and potentially the Penarth Group (Secondary Undifferentiated Aquifer) and Redcar Mudstone Group (Secondary B Aquifer). **Construction**: The proposed development is anticipated to include piled foundations and deep excavations which may form preferential pathways for contaminant migration through the Unproductive Strata, particularly while the deep excavations are exposed. There may be the potential for preferential pathways to be formed through the Unproductive Strata to Secondary B and Secondary Undifferentiated aquifers. It is noted however that the latter are also low permeability aquifers, and that no SPZs, drinking water safeguard zones or potable water abstractions are located within 1 km of the site. The area surrounding the site is also noted to be heavily industrialised. As such, groundwater in the shallow aquifers underlying the site is considered to be of low sensitivity.
Principal Aquifer	Vertical migration of contaminants via preferential pathways	The Sherwood Sandstone Group is located at significant depth (greater than 200 mbgl) at the site and is overlain by a significant thickness of lower permeability aquifers. As such, the risk of contaminant migration to the Principal Aquifer is considered to be negligible.

Receptor	Key Potential Pathways	Comments
Surface water receptors	Lateral and vertical migration of contaminants in Made Ground	The nearest surface water receptor to the site is Holme Beck (320 m south of the site at its closest, non-culverted point). Given the significant distance of Holme Beck from the site, and location up-hydraulic gradient of the site (at its closest non-culverted point) contamination is unlikely to migrate from the site to Holme Beck.
Surface water receptors	Lateral and vertical migration of contaminants in shallow bedrock aquifers	Given the low permeability and insistency of the shallow bedrock aquifers, the risk of migration of contaminants from the site to Holme Beck or the other surface water receptors via shallow aquifers is considered to be low (as with migration in Made Ground, Holme Beck is up-hydraulic gradient of the site at its closed non-culverted point).

3.5 Preliminary Risk Assessment

Potential pollutant linkages are identified using the source-pathway-receptor framework detailed in Appendix A. An assessment of the potential significance of each linkage is then made by consideration of the likely magnitude and mobility of the source, the sensitivity of the receptor and nature of the migration/exposure pathways between them.

This qualitative hazard assessment has been undertaken in accordance with National House Building Council (NHBC) and EA guidance[8]. Although the site is not being developed for housing, the risk assessment framework contained within that document is nationally accepted and considered appropriate for use for the proposed development. Further details of which are provided in Appendix A including definition of risk categories.

The conceptual site model associated with the proposed development as assessed at the end of the Phase 1 stage is summarised in Table 3-8.

The CSM is derived from the CSM presented in the Arcadis report[3] for the wider Grangetown Prairie site. Additionally, the CSM has been updated to reflect the currently proposed BA development. However, it is noted that the final design is not known and detailed information on below ground structures, soft landscaping and drainage has not been finalised.

[8] NHBC and EA (2008). Guidance for Safe Development of Housing on Land Affected by Contamination. R&D Publication 66:2008

Table 3-8: Conceptual Site Model (Phase 1)

Hazard	Pathway	Potential Receptor	Potential Consequence	Probability of Risk	Level of Risk
Sources (on-site and off-site) Former iron and steel works, including rail lines and sidings, pipelines, blast furnaces, coke ovens, steel mills, engine house, paint shop, chimneys, tanks, electricity substations, Made Ground and potentially infilled ground. Contaminants – Metals, calcium, phosphorus and sulphur oxides, asbestos, fluorides, sulphates, phosphates, TPH, PAH, phenols, VOCs, SVOCs, BTEX, PCBs, ground gas/vapours	Dermal contact/ingestion of soil/groundwater/dust/inhalation of dusts	Future site users (commercial)	Medium	Unlikely	Low
		Construction/maintenance workers	Medium	Likely	Moderate*
	Inhalation of asbestos fibres	Future site users (commercial)	Medium	Unlikely	Low
		Construction/maintenance workers	Medium	Likely	Moderate*
	Accumulation and inhalation of gas/vapours in confined spaces	Future site users (commercial)	Medium	Low likelihood	Moderate/low
		Construction/maintenance workers	Medium	Likely	Moderate*
		On-site buildings	Medium	Low likelihood	Moderate/low
	Permeation of contaminants into drinking water supply pipes	Future site users (commercial)	Medium	Low likelihood	Moderate/low
	Root uptake of phytotoxic contaminants	Plants in soft landscaping	Mild	Low likelihood	Low
	Migration of contaminants in groundwater via preferential pathways (i.e. piled foundations)	Secondary B and Secondary Undifferentiated Aquifers	Mild	Likely	Moderate/low
		Principal Aquifer	Medium	Unlikely	Low
		Surface watercourses	Mild	Unlikely	Very low
	Lateral and vertical contaminant migration in Made Ground and shallow bedrock aquifers	Surface watercourses (Holme Beck and Knitting Wife Beck)	Mild	Unlikely	Very low
		Surface watercourses (River Tees)	Mild	Unlikely	Very low

Hazard	Pathway	Potential Receptor	Potential Consequence	Probability of Risk	Level of Risk
Off-site sources – Gasworks, potentially infilled land, fire station. Contaminants – Cyanide, ground gas/vapours, PFOS/PFOA	Leaching and vertical migration of contaminants onto site in soil and groundwater with accumulation and inhalation of gas and vapours in confined spaces	Future site users (commercial)	Minor	Low likelihood	Very low
		Construction/maintenance workers	Medium	Low likelihood	Moderate/low*
		Buildings	Minor	Low likelihood	Very low
		Secondary B and Secondary Undifferentiated Aquifers	Mild	Low likelihood	Low

Notes:

Assessment completed assuming site in pre-remediation condition. Should site levels be significantly altered during development, a reassessment might be required

Should the development proposals alter significantly from that outlined in section 2.2 a review of this assessment may be required

* Given the use of appropriate personal protective equipment (PPE) and on-site health and safety precautions, risk to site construction and maintenance workers would be reduced to low.

3.6 Appropriateness of Phase 1 Assessment

The potential risks and pollutant linkages illustrated in the CSM for the site are comparable to those identified by the Arcadis report[6] and other noted sources, as follows:

- Risk to future site users and groundworkers from contaminants in soil via direct contact/ingestion with soils and/or groundwater or inhalation/ingestion of dust/fibres;
- Risk to future site users, buildings and structures from infiltration of organic contaminants into drinking water supply pipes;
- Risk to future site users, groundworkers and buildings from accumulation of asphyxiating/explosive gases/vapours in enclosed spaces; and
- Risk to Secondary B / Secondary (Undifferentiated) Aquifers from vertical migration of contaminants in permeable strata or via preferential pathways such as building foundations.

It is therefore considered that the desk based assessments completed for the wider Grangetown Prairie site reviewed within this report are appropriate, relevant and detailed enough to adequately assess the risks associated with the BA site, as collated and presented in Table 3-8.

3.7 Data/Assessment Gaps

Given the final site layout is unknown at this time the specific infrastructure that will be used on site has not been determined, including the details and dimensions of any deeper structures such as the use of basements and piles (although it is expected that piles will be installed at the site). Information on drainage and landscaping has not been finalised at this point.

4. PHASE 2 SITE ASSESSMENT

4.1 Source Documentation

Table 4-1: Phase 2 Ground Investigation Factual Reports and Interpretative Reports

Report	Relevant Planning Application
AEG (2020). Final Factual Report (Rev.01), Prairie Site Ground Investigation Works, Ref 4251[9]	R/2020/0318/FFM
AEG (2020). Draft Factual Report (Rev.01), Tees Valley Energy Recovery Facility, Ref 4289[10]	R/2020/0318/FFM
Arcadis (2020). Phase II Environmental Site Assessment, Grangetown Prairie Area, Former Steelworks, Redcar, Ref 10035117-AUK-XX-XX-RP-ZZ-0062-01-Prairie_ESA[11]	R/2020/0318/FFM
Arcadis (2020). Phase II Environmental Site Assessment - Addendum, Grangetown Prairie Area, Former Steelworks, Redcar, Ref 10035117-AUK-XX-XX-RP-ZZ-0062-01-Prairie_ESA_Addendum[12]	R/2020/0318/FFM
Stantec (2020). Geoenvironmental and Geotechnical Ground Investigation Report – Tees Valley ERF Site, Grangetown Prairie, Redcar, TS10 5QW, Ref RPT_41527104_RT-NN-2789-01[13]	R/2019/0767/OOM

Ground investigation data from exploratory holes undertaken within the site boundary by AEG (4251)[9] was subject to interpretation by Arcadis[3] (and is hereafter referred to as the 'Arcadis ground investigation'). These reports have been used to undertake the following site assessment in Section 4 below.

The Arcadis Phase II Site Environmental Site Assessment[3] made use of historical data obtained by the Enviros (2007) and Shadbolt (2011) ground investigation reports which were not provided to Ramboll. Where data and exploratory hole locations from these ground investigations were specified by Arcadis, they have been incorporated into this Phase 2 Site Assessment.

Ground investigation data from exploratory holes undertaken by AEG (4289)[10] has been subject to interpretation by Stantec[13] (and is hereafter referred to as the 'Stantec ground investigation'). However, these locations refer specifically to the ERF site adjacent to the western boundary of the BA site, and as such these reports have not been included in the assessment in Section 4.

4.2 Ground Investigation Works

A summary of known exploratory hole locations within the site is presented as Table 4-2. A plan of exploratory hole locations within the site is presented in Appendix A.

[9] AEG (2020). Final Factual Report (Rev.01), Prairie Site Ground Investigation Works, ref. 4251

[10] AEG (2020). Draft Factual Report (Rev.01), Tees Valley Energy Recovery Facility, ref. 4289

[11] Arcadis (2020). Phase II Environmental Site Assessment, Grangetown Prairie Area, Former Steelworks, Redcar, ref. 10035117-AUK-XX-XX-RP-ZZ-0062-01-Prairie_ESA

[12] Arcadis (2020). Phase II Environmental Site Assessment - Addendum, Grangetown Prairie Area, Former Steelworks, Redcar, ref. 10035117-AUK-XX-XX-RP-ZZ-0062-01-Prairie_ESA_Addendum

[13] Stantec (2020). Geoenvironmental and Geotechnical Ground Investigation Report – Tees Valley ERF Site, Grangetown Prairie, Redcar, TS10 5QW, ref. RPT_41527104_RT-NN-2789-01

Table 4-2: Summary of Exploratory Hole Locations

Report	Hole		Installation Depths (mbgl)	Installation Response Zone*
AEG (Ref 4251)	9 trial pits to depths ranging from 0.1 mbgl to 4.5 mbgl	Not installed		
	Two boreholes (cable percussive) to depths of 8.0 mbgl and 12.0 mbgl	BH102	2.0 – 7.2	Made Ground
		BH105	8.0 – 11.00	Glaciolacustrine deposits
Shadbolt (2011)	One trial pit (TP09) and one PB (PB14. Depth details are not noted by Arcadis.	Install details not recorded by Arcadis		

4.3 Ground Conditions Encountered

4.3.1 Strata

A summary of the ground conditions encountered at the site by the Arcadis[3] ground investigation is presented as Table 4-3. The strata descriptions are adapted from the Arcadis Ground investigation Report and the AEG factual report that was specific to the BA site.

Table 4-3: Summary of Ground Conditions Encountered (adapted from AEG (2020) and Arcadis (2020))

Strata	Description	Depths of Stratum (m bgl)
Made Ground	(Grass over) Brown sandy Topsoil (not present in all locations)	0.0 to 0.4
	Concrete (potentially reinforced with or without rebar or found as a slab) or brick*.	0.1 to 1.8
	Reworked sandy/gravelly clay, or clayey / silty sand, gravel or rare cobbles/boulders of brick, tile, coal, slag, ash, concrete, paper, wood, plastic, and/or metal fragments. Slag and ash found in varying quantities from 0-100 %. Slag is often vesicular.	0.0 to 4.5
Tidal Flat Deposits (Alluvium)	Soft to firm brown/grey/orange or brown mottled grey clay or sandy clay. Occasional fine to coarse gravel, and pockets of yellow/brown sand noted.	1.3 to 2.6
Glaciolacustrine Deposits	Soft to firm frequently thinly or occasionally indistinctly laminated brown/grey/orange or brown mottled grey clay. Occasional fine sand noted on laminae.	2.5 to 6.7
Glacial Till	Firm to very stiff occasionally friable dark brown/brown/red/brown clay or sandy/gravelly silt or clay with rare sub-angular cobbles or yellow brown clayey sand or fine or coarse frequently loose sand or sand and gravel or dense grey-brown very sandy gravel. Gravel is fine to coarse and sub-angular to sub-rounded. Gravel and cobbles include sandstone, limestone, gypsum and flint, with gravel of coal noted as possible Made Ground.	6.7 to 11.0
Mercia Mudstone Group	Extremely weak dark red mudstone with some gypsum interbedding (recovered as gravelly sand).	11.0 to 12.0

* Concrete was found to be widespread across the site (though not in a continuous layer) and is likely to be present as localised footings, previous foundations and broken slabs used for previous infill material.

It is noted that the descriptions for Tidal Flat Deposits and Glaciolacustrine Deposits are very similar, and logs may not correctly represent the boundary between the two strata. Since separate identification could not be positively undertaken based on these descriptions, they are considered broadly as low permeability, shallow superficial deposits overlying the Unproductive Strata of the Glacial Till for the purposes of this report.

4.3.2 Groundwater Levels

Three rounds of groundwater monitoring were undertaken at one location on the site by Arcadis on 06 May 2020, 15 June 2020 and 30 June 2020. Groundwater levels recorded at the site by Arcadis are detailed in Table 4-4.

Table 4-4: Summary of Groundwater Level Monitoring (adapted from Arcadis, 2020[6])

Borehole	Aquifer	6 May 2020 Groundwater Elevation (mAOD)	15 June 2020 Groundwater Elevation (mAOD)	30 June 2020 Groundwater Elevation (mAOD)	Range in Depth to Groundwater (mbgl)
BH102	Made Ground	7.11	7.38	7.31	0.83-1.1
BH105	Glacial Till / Mercia Mudstone	3.66	3.77	3.75	4.49-4.6

BH105 is screened in a band of slightly clayey very sandy gravel at the base of the Glacial Till and directly above the Mercia Mudstone. Based on the groundwater elevations measured over the three groundwater monitoring rounds, the groundwater in BH105 is considered to be in continuity with the bedrock aquifer.

The water within the Made Ground was deemed by Arcadis to be perched water.

Arcadis measured the flow direction over the entire Grangetown Prairie site within the superficial deposits and the bedrock (noted – no Made Ground assessment has been carried out). Arcadis determined that the groundwater flow was generally towards to northeast in both the superficial deposits and the bedrock.

The Arcadis report noted that the inferred flow directions within the superficial deposits and the bedrock were based on information from a limited number of monitoring wells, that may be influenced by local ground conditions. The River Tees is located to the north of the site and flows to the east, towards the North Sea. The groundwater flow direction inferred for the groundwater for both superficial and bedrock aquifers is therefor considered to be in line with the regional hydrogeology.

In addition to the groundwater level monitoring detailed in the Arcadis report[6], continuous groundwater level monitoring was undertaken as part of the Arcadis ground investigation[6] in BH101D (located offsite, to the northeast in the Glacial Till Deposits) between 12 May 2020 and 18 June 2020. Continuous groundwater monitoring was selected in order to assess groundwater fluctuations over the period of a complete tidal cycle. Arcadis concluded that while there was evidence of regular cycles in groundwater levels that may reflect changes in the tides, there was insufficient evidence to conclusively state that the groundwater is tidally influenced.

4.3.3 Visual and Olfactory Evidence of Contamination

A summary of visual/olfactory evidence of contamination identified at the site by Arcadis[3] is presented in Table 4-5.

Table 4-5: Summary of Visual/Olfactory Evidence of Contamination (adapted from Arcadis, 2020)

Report	Location	Observation	Depth (mbgl)	Description
AEG (4251) and Arcadis	TP114	Visual and Olfactory	0.9	Black tar with hydrocarbon odour running out of clay pipe. Also surrounding the pipe.
	TP121	Olfactory	1.2 to 4.5	Slight hydrocarbon odour
	TP122	Olfactory	0.0 – 1.2	Slight hydrocarbon odour
	TP145	Olfactory	1.6 to 1.7	Slight hydrocarbon odour
	TP146C	Olfactory	0.9 to 1.4	Slight hydrocarbon odour
	BH102	Olfactory	0.9 to 8.0	Slight hydrocarbon odour

Table 4-5 indicates the potential presence of non-aqueous phase liquids (NAPL) or free product in Made Ground and perched water at one location (TP114) in the northeast of the site. Visual/olfactory evidence of contamination identified at the site by the Arcadis ground investigation was found at locations across the entire site. Arcadis noted the presence of similar evidence of contamination at numerous locations across the wider Grangetown Prairie site.

4.4 Contamination Testing

A variety of chemical testing was undertaken on soil, soil leachate and groundwater as part of the Arcadis[3] ground investigation. The suite of chemical testing included material parameters (pH, total organic carbon, loss on ignition, metals, asbestos, inorganic compounds (sulphate, cyanide, chloride), benzene, toluene, ethylbenzene and Xylene (BTEX), Total Petroleum Hydrocarbons (TPH), polyaromatic hydrocarbons (PAH), PCBs, phenols, methyl-tert-butyl-ether (MTBE), volatile organic compounds (VOCs) and pesticides.

4.5 Risk Assessments

The risk assessments undertaken as part of the Arcadis[3] reports have been summarised below in relation to the site.

4.5.1 Human Health Risk Assessment

Soils

To evaluate potential risks to human health receptors, Arcadis[3] screened soil sample testing results obtained during their ground investigations (AEG 4251[9]) against generic assessment criteria (GAC) for a commercial/industrial land use. A soil organic matter (SOM) value of 1 % was adopted in both cases. The GACs were derived from the following in order of priority:

- Land Quality Management / Chartered Institute of Environmental Health (LQM / CIEH) Suitable for Use Levels (S4UL);
- Department of Environment Food and Affairs (DEFRA) Category 4 Screening Levels (C4SL);
- Arcadis derived GACs based on Contaminated Land Exposure Assessment (CLEA) v1.07; and
- United States Environmental Protection Agency (US EPA) Regional Screening Levels (RSLs).
- Wood derived GAC based on CLEA v1.07, presented in the Wood 2019 report[2].

A summary of the GAC exceedances is shown in the table below:

Table 4-6: Summary of GAC Exceedances

Contaminant	Unit	GAC exceeded		Sample	Concentration
Naphthalene	mg/kg	Wood	1900	PRAIRIE_AUK_TP114_SO_0090	37,000
Phenanthrene	mg/kg	S4UL	22000	PRAIRIE_AUK_TP114_SO_0090	22,000
Benzo(a)anthracene	mg/kg	S4UL	170	PRAIRIE_AUK_TP114_SO_0090	4600
Chrysene	mg/kg	S4UL	350	PRAIRIE_AUK_TP114_SO_0090	3600
Benzo(b)fluoranthene	mg/kg	S4UL	44	PRAIRIE_AUK_TP114_SO_0090	91
Benzo(a)pyrene	mg/kg	Wood	77	PRAIRIE_AUK_TP114_SO_0090	92
Dibenzo(a,h)anthracene	mg/kg	S4UL	3.5	PRAIRIE_AUK_TP114_SO_0090	8.4
Dibenzofuran	mg/kg	USEPA	1000	PRAIRIE_AUK_TP114_SO_0090	3300

All exceedances from the site were from the same sample in TP114 at 0.9 m bgl. This is from a sample of tar from a pipe found in the trial pit. Material of this nature would be removed as part of a remedial strategy prior to the development of the site and is not considered to be representative of wider ground conditions.

Arcadis[3] identified two historical site investigation locations within the site boundary: Shadbolt locations TP09 and PB14. Neither of these locations had samples that exceeded the GACs. It is noted that Ramboll has not seen the original reports and raw data for the Shadbolt site investigation.

Arcadis[3] carried out a qualitative assessment of a number of determinants for which they did not possess GACs, and concluded that these could present a risk to human health. These determinants were cyanide and PCBs.

To further assess the risk from PCB and PAHs to future site commercial workers via the vapour inhalation pathway, Arcadis screened on the basis of the Henry's Law constant, relating the contaminant concentration in the vapour phase to that in the (pore) water phase. All PAHs and PCBs with the exception of naphthalene were not deemed to be a risk. The naphthalene concentration was localised and related to a tar pipe found in TP114.

Asbestos was found in TP135 at 1.3 m bgl. The asbestos was below the limit of detection of (0.001 % v/v).

Vapours from Groundwater

Arcadis[3] assessed 12 groundwater samples from the whole area of the Grangetown Prairie for risks associated with inhalation of volatile contaminants (VOCs) in groundwater, using GACs which were derived by Arcadis using the CLEA process and industry standard vapour transport modelling. A commercial/industrial end use was assumed, and an on-site commercial worker was considered as the receptor. No exceedances of the GACs were identified in the 12 samples of groundwater tested by Arcadis.

Cyanide and Naphthalene

Elevated concentrations of free cyanide (in soils and groundwater) and naphthalene (in soils) were noted by Arcadis to require further investigation due to the potential to pose a risk to human health via direct contact and vapour volatilisation. As such, generic assessment criteria (GACs) were derived to assess the risk to human health from soil and groundwater from free cyanide based on a generic land use incorporating soil parameters at Grangetown Prairie by Arcadis using the CLEA model and

Risk-Based Corrective Action (RBCA) tool[5]. No exceedances of this derived GAC for free cyanide were identified at Grangetown Prairie. Arcadis[5] noted that elevated naphthalene concentrations in soils were associated with areas of identified NAPL, and as such the removal of NAPL would mitigate the remaining risk to human health. As such, Arcadis concluded that the risk to human health from free cyanide at Grangetown Prairie (and by extension, the site) would be low provided that NAPL was removed as part of the remediation works.

Water Supply Permeation

Arcadis[3] screened soil samples from the wider Grangetown Prairie against the UK Water Industry Research (UKWIR) screening thresholds for polyethylene (PE) plastic drinking water supply pipes. While Arcadis did not detail the exact locations of exceedances, 8 % of the soil samples across the wider Grangetown Prairie site were noted to exceed the screening thresholds for phenols and 47.6 % exceeded the screening thresholds for SVOCs, and thus Arcadis recommended additional testing along the route of any proposed new water supply pipes, or for barrier pipe or similar to be used instead.

Soil samples specific to the site have not been screened against the UKWIR thresholds by Ramboll, however given the presence of elevated concentrations of organic contaminants recorded at the site in addition to visual/olfactory evidence of organic contaminants recorded at locations on the site, it is likely that the site will be similarly unsuitable for PE plastic drinking water supply pipes.

4.5.2 Controlled Waters Risk Assessment

Groundwater

To evaluate potential risks to groundwater, Arcadis[3] screened samples of soil leachate and groundwater obtained during their ground investigation (AEG 4251[9]) against GACs derived from the following water standards:

i. Estuaries and Coastal Waters (Water Supply (Water Quality) Regulations 1989[14];
ii. Drinking Water Standard (DWS) (2000) Regulations[15];

A number of the regulations above are noted to have been superseded by more up to date guidance. These are as follows:

i. Water Supply (WQ) Regulations 2016 Drinking Water (Drinking Water Inspectorate) – superseded by the Water Supply (Water Quality Regulations 2016) England) (with 2018 amendments consolidated).
ii. Water Supply (Water Quality) Regulations 1989 – superseded by the Water Supply (Water Quality Regulations 2016) England) (with 2018 amendments consolidated).

The updates to the Water Supply (WQ) Regulations listed above are not anticipated to change the outcomes of the Arcadis assessments reviewed by Ramboll.

A total of 24 samples of soil leachate were obtained from the wider Prairie site. Two of the samples are from within the BA site boundary (TP114 0.9 m bgl and TP145 1.6 m bgl). Both are located within the Made Ground. A summary of the exceedances recorded at the site is presented as Table 4-7.

Table 4-7: Summary of Soil Leachate Exceedances

Contaminant	Unit	WQS exceeded		Sample	Concentration (µg/l)
Copper	µg/l	EQS	3.76	TP145. 1.6 m bgl	4.2
TPH	µg/l	EQS	50	TP114. 0.9 m bgl	3700

[14] The Water Supply (Water Quality Regulations (1989) No 1147
[15] The Drinking Water (Undertakings) (England and Wales) Regulations 2000 SI No. 1297

Contaminant	Unit	WQS exceeded		Sample	Concentration (µg/l)
Naphthalene	µg/l	EQS DWS	2 2	TP114. 0.9 m bgl	10000
Benzo(b)fluoranthene	µg/l	EQS DWS	0.017 0.025	TP114. 0.9 m bgl TP145. 1.6 m bgl	12 3.7
Benzo(k)fluoranthene	µg/l	EQS DWS	0.017 0.025	TP114. 0.9 m bgl TP145. 1.6 m bgl	4.6 1.3
Benzo(a)pyrene	µg/l	EQS DWS	0.027 0.01	TP114. 0.9 m bgl TP145. 1.6 m bgl	8.6 2.2
Ideno(1,2,3-c,d)pyrene	µg/l	DWS	0.025	TP114. 0.9 m bgl TP145. 1.6 m bgl	5.7 2.2
Benzo(g,h,i)perylene	µg/l	EQS DWS	0.027 0.01	TP114. 0.9 m bgl TP145. 1.6 m bgl	5.6 2.9
Phenol	µg/l	EQS DWS	7.7 7.7	TP114. 0.9 m bgl	2600

Leachate testing is undertaken on soil samples in the laboratory by vigorous mixing of soil and water to ascertain the degree to which contaminants in soil may leach into the dissolved phase. The process represents a 'worst-case' scenario as the vigorous laboratory process would not be expected to be replicated on site either during construction or operation. As such, the leachate testing results generally provide an overestimation of the true leachability of contaminants from soils. The exception is for volatile substances, which may volatilise and be lost during the leachate preparation process as such leachate results for VOCs should be treated with caution.

A total of two samples of groundwater were taken within the site from boreholes BH102 and BH105 and an additional 'grab sample' from TP115 groundwater. All three samples were analysed and screened against EQS and DWS. A summary of the distribution of exceedances recorded at the site is presented in Table 4-8.

BH102 is screened within the Made Ground. BH105 is screened within the Glacial Till, however is considered to represent the bedrock aquifer as discussed in Section 4.3.2.

It is noted that grab samples are taken from the site surface or from trial pits during excavation. As such these are likely to be unrepresentative of in-situ ground conditions due to disturbance as part of the investigation/sampling process, and may skew overall groundwater monitoring results to include more GAC exceedances than samples taken in stable conditions.

Table 4-8: Summary of Groundwater Exceedances

Contaminant	Unit	WQS exceeded		Sample	Concentration (µg/l)
Barium	µg/l	DWS	700	BH102	1000
Chromium	µg/l	DWS	50	TP115	110
Copper	µg/l	EQS	3.76	TP115	11
Manganese	µg/l	DWS	50	BH105	810
Zinc	µg/l	EQS	7.9	TP115	86

Contaminant	Unit	WQS exceeded		Sample	Concentration (µg/l)
Total Cyanide	µg/l	EQS DWS	1 50	TP115	71
Ammoniacal Nitrogen*	µg/l	DWS	0.5	BH102 TP115	1 0.54
TPH	µg/l	EQS DWS	50 10	TP115	180
Naphthalene	µg/l	EQS DWS	2 2	BH102	3.7
Benzo(b)fluoranthene	µg/l	EQS DWS	0.017 0.025	BH102 TP115	0.03 0.83
Benzo(k)fluoranthene	µg/l	EQS DWS	0.017 0.025	TP115	0.3
Benzo(a)pyrene	µg/l	EQS DWS	0.027 0.01	BH102 TP115	0.02 0.56
Ideno(1,2,3-c,d)pyrene	µg/l	DWS	0.025	TP115	0.38
Benzo(g,h,i)perylene	µg/l	EQS DWS	0.027 0.01	TP115	0.52

*DWS for ammoniacal nitrogen is for ammonium as NH_4.

Exceedances of at least one groundwater GAC were recorded in all samples of soil leachate and groundwater across the site in all strata from which samples were taken, indicating poor groundwater quality at the site as a whole and the potential for contamination to leach from strata should conditions facilitate this.

Arcadis[3] described similar exceedances of the groundwater GACs at the site and across the wider Grangetown Prairie, in addition to noting the presence of NAPL and tar elsewhere on Grangetown Prairie. Based on the recorded exceedances, Arcadis recommended that further investigation of groundwater impacts should be undertaken, including a detailed quantitative risk assessment (DQRA).

In the Arcadis Detailed Conceptual Site Model Review[5] further cyanide risk assessment was undertaken. The derivation of a GAC was completed by modelling of the risk from cyanide to human health using both the CLEA tool (produced by the EA) and the RBCA tool, which has been adapted to incorporate EA guidance. Based on the results of the modelling, GACs were created for soil and groundwater. None of the soil or groundwater results on site exceed the GACs. Arcadis therefor assessed that the risk to commercial workers from measured concentrations of free cyanide in soil and groundwater beneath the site is not significant.

Further assessment of groundwater was undertaken by Arcadis[6] in August 2020. As part of this assessment, Arcadis noted that Grangetown Prairie had some potential for saline intrusion, with brackish water recorded on parts of Grangetown Prairie. There is therefore the potential for this to also be the case in the site. Permeability testing was undertaken in off-site boreholes within the wider Prairie area, and Arcadis calculated permeability in the Glacial Till to range from 0.007 m/day to 0.025 m/day with an average of 0.015 m/day across four tests. Permeability calculated in the Mercia Mudstone Group ranged from 0.3 m/day to 0.61 m/day, with an average permeability of 0.5 m/day across 12 tests. Arcadis noted the calculated permeability of Mercia Mudstone Group to be

three orders of magnitude higher than expected and concluded that this may have been due to drilling induced fractures due to the mudstone being moderately weak in some sections of the well. Arcadis considered the permeability testing results to be representative of low permeability geology and unlikely to support significant groundwater flow.

Based on the results of salinity and permeability testing, combined with the industrial setting of the site, thickness of low permeability strata and the absence of sensitive receptors, Arcadis[5,6] concluded that the risk from contaminants in groundwater at Grangetown Prairie to sensitive receptors to be low, and discounted groundwater from further assessment. While this low risk is anticipated to apply to the site also, it is noted that the EA specified the risk to controlled waters beneath Grangetown Prairie would not be considered acceptable without further assessment.

Surface Waters

Arcadis[3] carried out surface water sampling in Holme Beck and screened the results against the freshwater EQS. All determinands were recorded at less than the relevant EQS with the exception of fluoranthene and benzo(g,h,i)perylene, where the limit of detection was greater than the EQS. Arcadis noted that there was little change in contaminant concentrations between the samples taken up-stream of the site those taken down-stream, and that what elevated concentrations were recorded were due to slag in Made Ground on Grangetown Prairie. As slag is present across both the site and the wider Grangetown Prairie, the site is not considered to present a greater risk to surface water receptors than the surrounding area.

4.5.3 Ground Gases

Arcadis[6] carried out three rounds of ground gas monitoring across the wider Grangetown Prairie area *"across a range of weather and atmospheric conditions"*, however factual data from the ground gas monitoring visit was not included in the factual report or site investigation report provided to Ramboll, and no interpretation of the data was provided in the environmental assessment report addendum.

There is no specific gas monitoring data for the BA site.

The environmental assessment report addendum recorded the following ground gas results for an off-site borehole adjacent to the western boundary of the site:

- Flow rates ranging from 0.0 l/hr to -7.1 l/hr;
- Maximum CH_4 concentration of 0.5% v/v in BH108S (not located on the site);
- Maximum H_2S concentration of 1 ppm in BH108S; and
  Maximum CO concentration of 6 ppm in BH108S.

The limited ground gas data available for the site and surrounding area generally correlates to Characteristic Situation CS1, however BS8576:2013 (Guidance on Investigations for Ground Gas)[16] requires that sufficient ground gas monitoring data is obtained to allow prediction of worst case site conditions. Insufficient monitoring rounds were undertaken as part of the AEG ground investigation[9]. Additionally, Arcadis noted that with the exception of BH108S, groundwater levels were recorded above the response zones of each monitoring well during all monitoring rounds, and as such representative ground gas concentrations were unlikely to be recorded. Conditions recorded in BH108S therefore have the potential to be more widespread than the monitoring indicates.

[16] BS 8576:2013. Guidance on investigation for ground gas – Permanent gases and volatile organic compounds (VOCs)

Arcadis noted that as a significant proportion of Made Ground across Grangetown Prairie would be excavated, processed and replaced as part of remediation for a commercial end use, further ground gas monitoring should be undertaken following the completion of remedial earthworks in order to monitor site conditions as they would be during the operational phase of the development. Given the proposal to undertake large-scale excavation and earthworks at the site, Ramboll supports Arcadis' recommendations.

4.5.4 Phase 2 Conceptual Site Model

Based on the ground investigation works undertaken at the site as interpreted by Arcadis[3,5,6], an updated CSM is presented in Table 4-9 to Table 4-12.

Table 4-9: Summary of Potentially Significant Contaminants Identified (Phase 2)

Sources	Contaminant	Comment
Contaminants in soils	Cyanide (Total)	Arcadis Detailed CSM review found that no soil or groundwater cyanide levels were above the GAC and presented low risk to human health.
	Hydrocarbons	Visual evidence of hydrocarbons (tar from a broken pipe) was observed at one location, and olfactory evidence was found in an addition five locations across the site. Similar conditions identified at Grangetown Prairie[3] indicate that PE plastic drinking water supply pipes may be unsuitable for use on the site.
	Asbestos	Asbestos was identified in 1 sample on the site (it is unknown how many samples were taken on the BA site in total). The concentration of asbestos in the sample was <0.001 % v/v.
Contaminants in groundwater	Metals, cyanide, TPH, PAH, ammoniacal nitrogen, BTEX, VOCs	Exceedances of the GACs for metals, cyanide, PAH and TPH were recorded in groundwater and soil leachate across the site in Made Ground, superficial deposits and the Mercia Mudstone Group. It is noted that some of the GAC exceedances are from a 'grab sample' from a Trail Pit, is unlikely to provide a fair representation of the groundwater regime for the site.
Ground Gas	Ground gas and vapours	Limited ground gas data is available for the wider Grangetown Prairie site. Existing data suggests a classification of CS1, however additional data is required to confirm classification following remediation works.

Table 4-10: Summary of Potential Receptors (Phase 2)

Receptor	Comments
On-site	
Future site users (Commercial/industrial)	Future staff of and visitors to the proposed BA plant, including below ground level (if applicable)
Construction/maintenance workers	Workers involved in construction of the proposed BA plant and future maintenance workers, including below ground level (if applicable).
Buildings and structures	Building materials used below ground level (e.g. foundations, drainage structures, water supply pipes).
Soft landscaping and SuDS (localised permeable surfaces)	Areas of soft landscaping and sustainable drainage solutions forming part of the external spaces of the development should this be applicable to the design.

Receptor	Comments
Groundwater receptors (Secondary B / Undifferentiated Aquifers)	Bedrock of limited permeability underlying Made Ground at the site. These comprise the Mercia Mudstone Group (Secondary B Aquifer) and potentially the Penarth Group (Secondary Undifferentiated Aquifer) and Redcar Mudstone Group (Secondary B Aquifer).
Groundwater receptors (Principal Aquifer)	The Sherwood Sandstone Group (Principal Aquifer), located at depth beneath the site.
Off-site	
Surface Water Receptors (Holme Beck, Knitting Wife Beck)	Small, unclassified surface water receptors located in Grangetown Prairie, located 320 m southwest of the site and 100 m east of the site respectively and draining to the River Tees via the Cleveland and Lackenby Channels. Holme Beck is culverted from 320 m south of the site until entering the Cleveland and Lackenby Channels.
Surface water receptors (River Tees)	The River Tees, located 1.64 km northwest of the site at its closest point. Classified as 'Poor' ecological status, chemical status and overall status. Designated as a SSSI and SPA.

Table 4-11: Summary of Potential Pathways (Phase 2)

Receptor	Key Potential Pathways	Comments
Human health	Direct contact with contaminated soils or groundwater	Contaminants in exceedance of the GAC for human health at the site are limited to PAHs and dibenzofuran from one location in TP114. This is likely due to tar that was observed running from a below ground pipe. It is assumed by Arcadis that structures and contamination such as this will be removed during the remediation and remove the risk from this source. **Construction**: Construction workers have the potential to come into contact with contaminants in soil and groundwater during site enabling works and construction activities.
		Operation (including maintenance): The pathway to future site users is expected to be minimised by the presence of concrete foundations and hardstanding beneath the proposed buildings and car parking spaces. There may be some limited risk of exposure from the communal soft landscaping in parts of the site. Maintenance workers may have the potential to come into contact with contaminants in soil and groundwater if required to break ground during future maintenance works.
Human health	Inhalation and ingestion of dusts/fibres and inhalation of gas and vapours	Asbestos was identified in one sample. The concentration was <0.001 % v/v. **Construction:** Construction workers may be subject to accidental inhalation of accumulated vapour and ground gases when working in confined spaces such as excavations.
		Operation (including maintenance): The pathway to future site users is expected to be minimised by the presence of concrete foundations and hardstanding beneath the proposed buildings and car parking spaces. There may be some limited risk of exposure from the communal soft landscaping in parts of the site. Maintenance workers may be subject to accidental ingestion and inhalation of dust, fibres, vapour and ground gases. Risk is anticipated to be low as maintenance works will be at much smaller scale than construction works and whole site will not be exposed to atmosphere.
Human health	Accumulation of asphyxiating/explosive gases in confined spaces	Limited ground gas data is available for the site. Existing data suggests a classification of CS1, however additional data is required to confirm classification once the site has been remediated. **Construction:** Construction workers may be subject to accidental inhalation of accumulated vapour and ground gases when working in confined spaces such as excavations.

Receptor	Key Potential Pathways	Comments
		Operation (including maintenance): Enclosed spaces on the site are anticipated to be divided into above-ground space within the BA building, above-ground office spaces and any below-ground structures (if applicable). Above-ground space within the BA building is anticipated to be spacious and well-ventilated. Above-ground office spaces may be smaller and less well ventilated, and any below ground structures (if applicable) may present a risk of accumulation of asphyxiating/explosive ground gases and vapours. Future site users and maintenance workers working in office spaces and other enclosed spaces such as utility spaces may therefore be subject to accidental inhalation of accumulated vapour and ground gases.
Human health	Infiltration of organic contaminants into drinking water supply pipes	**Operation (including maintenance):** Organic contaminants have been identified in Made Ground at the site. While a UKWIR assessment specific to the site has not been undertaken, it is considered likely that PE plastic pipes will not be suitable for use at the site (as is the case on the wider Grangetown Prairie).
Buildings and structures (construction materials)	Damage to building materials or services through direct contact with contaminated soil/groundwater	**Construction (short term) and Operation (long term):** Aggressive ground conditions or organic contaminants such as hydrocarbons may affect subsurface construction materials such as foundations or drainage structures. Services may be affected by direct contact with aggressive soils or influx of contaminated groundwater.
Plants	Uptake of phytotoxic contaminants	**Operation (including maintenance):** Screening of potentially phytotoxic contaminants at the site was not undertaken as part of the Arcadis ground investigations, however phytotoxic metals were recorded in soils at elevated concentrations. Plants in areas of soft landscaping may therefore have the potential to be impacted by phytotoxic contaminants in soil at the site, should they be planted in or at a height above such soils where the root zone could intercept them or water be taken up by the plants.
Secondary B and Secondary (Undifferentiated) aquifers	Vertical migration of contaminants via preferential pathways	Chemical testing of soil leachate and groundwater at the site indicates that the groundwater is significantly impacted by contaminants across the site to a depth of at least 20 mbgl in the Mercia Mudstone Group. It was noted by and Arcadis[3] that the strata underlying the site comprise Unproductive Strata, Secondary B and Secondary (Undifferentiated) aquifers of low permeability. No potentially sensitive groundwater or surface water receptors are located in the vicinity of the site, and groundwater at the surrounding Grangetown Prairie is similarly impacted. The site and surrounding area have a similar industrial setting and are of similar low sensitivity with respect to groundwater contamination. This should be confirmed via completion of the Arcadis DQRA. **Construction:** The proposed development is understood to include piled foundations and potential deep excavations which may form preferential pathways for contaminant migration through the Unproductive Strata, particularly while the deep excavations are exposed. The development may also include SuDS (lined pond/attenuation tank and localised permeable surfaces), which may form preferential

Receptor	Key Potential Pathways	Comments
		pathways for rainfall infiltration, leaching and contaminant migration due to open excavations for the construction of the SuDS. There may be the potential for preferential pathways to be formed through the Unproductive Strata to Secondary B and Secondary Undifferentiated Aquifers. It is noted that the latter contain significant contaminant concentrations in groundwater suggesting that pathways through the Unproductive Strata currently exist. The Secondary B and Secondary Undifferentiated Aquifers are low permeability aquifers with minimal potential for contaminant migration to sensitive receptors which are located at a significant distance to the site. As such, the risk from preferential pathways due to the proposed development is considered to be low. Notwithstanding, this should be confirmed via the completion of a PWRA for the proposed development.
		Operation (including maintenance): If the development will include SuDS (localised permeable surfaces), they may form preferential pathways during the operational life of the development. Contaminant migration may occur via preferential pathways formed by piles and subterranean structures, however vertical leaching of contaminants by rainfall is anticipated to be limited in these areas following construction of the BA building.
Principal Aquifer	Vertical migration of contaminants	The depth of the Sherwood Sandstone Group beneath the site has not been proven, however is expected to be at least 200 m below ground level. As the Glacial Till and Mercia Mudstone Group underlying the site have been confirmed to be of low permeability, the risk to the Principal Aquifer is considered to be negligible.
Surface water receptors	Lateral and vertical migration of contaminants in Made Ground	The nearest surface water receptor to the site is Holme Beck (320 m southwest of the site at its closest, non-culverted point). Surface water testing carried out by Arcadis indicates that the impact on the surface water receptor by Grangetown Prairie is limited despite the industrial setting to the site. Given the site is located a much greater distance from Holme Beck than Grangetown Prairie, the risk to surface water receptors from the site is considered to be low and will not be considered further.
Surface water receptors	Lateral and vertical migration of contaminants in shallow bedrock aquifers	Given the low permeability of the shallow bedrock aquifers, the risk of migration of contaminants from the site to Holme Beck or the other surface water bodies is considered to be low and will not be considered further.

Updated potential pollutant linkages are identified using the method detailed in Section 3.6.

The CSM associated with the proposed development as assessed at the end of the Phase 2 stage is summarised as Table 4-12. The CSM is derived from the sources identified on site by the Arcadis ground investigations and the receptors and pathways identified as requiring further assessment by the Phase 1 CSM.

Table 4-12: Updated Conceptual Site Model (Phase 2)

Hazard	Pathway	Potential Receptor	Potential Consequence	Probability of Risk	Level of Risk
Sources Exceedances of the GACs for soil Organic contaminants in soil Ground gas Contaminants in groundwater	Dermal contact/ingestion of soil/groundwater/dust/inhalation of dusts	Future site users (commercial)	Medium	Low likelihood	Moderate/low
		Construction/maintenance workers	Medium	Likely	Moderate*
	Inhalation of asbestos fibres	Future site users (commercial)	Medium	Low likelihood	Moderate/low
		Construction/maintenance workers	Medium	Likely	Moderate*
	Accumulation and inhalation of gas/vapours in confined spaces	Future site users (commercial)	Medium	Low likelihood	Moderate/low
		Construction/maintenance workers	Medium	Low likelihood	Moderate/low*
		On-site buildings	Medium	Low likelihood	Moderate/low
	Permeation of contaminants into drinking water supply pipes	Future site users (commercial)	Medium	Likely	Moderate
	Root uptake of phytotoxic contaminants	Plants in soft landscaping	Mild	Low likelihood	Low
	Migration of contaminants in groundwater via preferential pathways (i.e. piled foundations, deep excavations, subterranean structures)	Secondary B and Secondary Undifferentiated Aquifers	Medium	Low likelihood	Moderate/low
		Principal Aquifer	Medium	Unlikely	Low

Notes:

Assessment completed assuming site in pre-remediation condition. Should site levels be significantly altered during development, a reassessment might be required

Should the development proposals alter significantly from that outlined in section 2.2a review of this assessment may be required

* Given the use of appropriate personal protective equipment (PPE) and on-site health and safety precautions, risk to site construction and maintenance workers would be reduced to low.

The CSM prepared for Grangetown Prairie by Arcadis[3] following ground investigation works identified the same source-pathway-receptor linkages confirmed at the site by the updated CSM presented as above. With respect to human health, these are as follows:

- Risk to human health (future site users and construction/maintenance workers) from direct contact/ingestion of contaminants in soil (PAHs, NAPL); and
- Risk to human health from inhalation of asbestos fibres.

The updated CSM additionally notes the following land contamination risks which have not been fully addressed by the ground investigations, however, were noted by Arcadis as requiring further works to be undertaken as part of remediation earthworks at the site:

- Risk to human health and on-site buildings from accumulation of ground gas in enclosed spaces (further ground gas monitoring required following completion of remediation earthworks);
- Risk to human health and on-site buildings from infiltration of organic contaminants into drinking water supply pipes (requires site-specific assessment of soil data against UKWIR thresholds and/or use of barrier pipe as part of the proposed development).

The EA additionally noted that they did not consider the risk to controlled waters at Grangetown Prairie (which includes the site) to be acceptable without appropriate investigation and assessment.

Beyond the generic commercial/industrial land use assumed by Arcadis for the investigation and remediation of Grangetown Prairie, the proposed development of the site as a BA Facility may incorporate additional features relevant to investigation/remediation of contaminated land; piled foundations, below ground structures, drainage, soft landscaping and SuDS (localised permeable surfaces). These features would typically be expected to have additional implications relating to groundwater conditions due to the requirement for deep excavations and increased soil infiltration (in areas of permeable surfaces) respectively.

Given the laterally and vertically widespread nature of groundwater contamination at the site, low permeability of the underlying geology and the low sensitivity of the environment to groundwater contamination, the inclusion of these features are not considered to result in an increased risk of contaminant migration to relatively less impacted locations or strata. Given the presence of NAPL in parts of the site, and the EA concerns with relation to groundwater at Grangetown Prairie, it is recommended that a watching brief and verification sampling exercise should be undertaken during the excavation of any below ground structures, drainage channels, other utilities and SuDS in line with the requirements for excavation of the ROA and Strategy (summarised in Section 5 of this report).

While the site is considered by Arcadis to be of lower sensitivity with respect to groundwater, it is recommended that a PWRA be undertaken for the proposed development, which can be secured via an appropriately worded planning condition, to confirm that piled foundations will not present a significant risk of contaminant migration in groundwater via preferential pathways. In combination with the watching brief and verification for deeper structures, drainage and landscaping aspects of the construction and the groundwater assessments undertaken by Arcadis to date, this is anticipated to fulfil the EA requirements for investigation of risks to groundwater.

4.6 Appropriateness of Phase 2 Assessment

The ground investigation works undertaken within the site to date indicate that the potential risks to human health and the water environment from the site are comparable to those identified on the wider Grangetown Prairie by Arcadis. No additional contaminant risks have been identified within the site and the proposed BA Facility development is not anticipated to result in additional risk beyond that of the generic commercial land use assumed for the wider Grangetown Prairie site by Arcadis.

Where data gaps exist in the ground investigations undertaken within the site, these have been previously identified by Arcadis as requiring further works during the remediation earthworks stage. As such, provided that these data gaps are suitably addressed within the remediation strategy prepared by Arcadis, the Phase 2 assessments undertaken to date are considered appropriate, relevant and detailed enough to adequately address the risks associated with the proposed BA development.

4.7 Data/Assessment Gaps

Data gaps requiring further assessment at the site include the following:

Data Gaps*	Reason	Comment
Completion of the Arcadis DQRA for Grangetown Prairie	To confirm that groundwater impacts have been fully investigated and addressed (anticipated to apply to the site also)	At the point that the Client takes on the site, this action should have been completed by other parties.
Ground gas monitoring	To confirm the ground gas regime at the site (to be undertaken after the enabling works stage and prior to construction of the proposed development)	Remediation of the site will 'invalidate' the existing ground gas monitoring results due to the large scale excavation and earth movement activities. Currently available data is limited. A new phase of monitoring would inform conditions as they would be during the operational phase of the development.
Assessment of soil data against the UKWIR thresholds	To confirm appropriate construction materials to be used in drinking water pipes (given the presence of organic contaminants in soil and widespread impacts in groundwater, barrier pipe may to be required across the site, depending on the post-remediation quality of the soils in which the pipes are laid)	Compliance of soils at the site post-remediation with UKWIR may be documented within verification reports or other documentation produced as part of the remediation works. If so, no further action may be needed. If not, then the relevant water authority may require confirmation of the suitability of soils for proposed supply pipe materials.
Preparation of a piling works risk assessment (PWRA)	To confirm that piled foundations will not present a significant risk of contaminant migration in groundwater via preferential pathways.	The EA do not consider the risk to controlled waters at Grangetown Prairie to be acceptable without appropriate investigation and assessment. Completion of a PWRA may be required to support any EA permit application at the site.
Detailed UXO Threat and Risk Assessment	To confirm any remaining level of UXO risk at the site in the context of the proposed development	This may or may not be needed, and specialist advice should be sought, as noted in Section 5.

5. REMEDIATION ASSESSMENT

5.1 Source Documentation

Remediation of the wider Grangetown Prairie (which includes the site) has been designed for a generic commercial land use. The details of the remediation design and verification of remediation on the adjacent site are outlined in the following reports:

- Arcadis (2020). Remediation Options Appraisal and Enabling Works and Remediation Strategy Report (DRAFT), Grangetown Prairie Area, Former Steelworks, Redcar, Ref 10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy[17] (in support of planning application R/2020/0318/FFM); and
- Arcadis (2021). Remediation and Earthworks Verification Report. TV ERF plot – Dorman Point, Teesworks. South Tees Development Corporation. 10035117-AUK-XX-XX-RP-ZZ-0351-03-TVERF_Verification[18].

The suitability of these reports in relation to the site, and any additional works required to be undertaken for the proposed development, are detailed in this section of the report.

5.2 Conceptual Site Model

5.2.1 Environmental Risks

The Remediation Options Appraisal (ROA) and Enabling Works and Remediation Strategy[17] was prepared by Arcadis based upon the information and assessments within the Phase 2 Environmental Assessment[3], Addendum[6] and CSM Review and Risk Assessment[5] for Grangetown Prairie. Based on the environmental assessments detailed above, the Arcadis ROA and Strategy was prepared to address the following end-use risks:

- Human health – risk to commercial workers via inhalation of asbestos fibres in shallow Made Ground across Grangetown Prairie;
- Human health – risk to commercial workers via dust inhalation and direct contact with arsenic, cyanide and selected PAHs (NAPL) in shallow soils across Grangetown Prairie; and
- Water resources – Arcadis noted that a DQRA was in progress at the time of writing of the ROA and Strategy, and assumed based on their completed assessments that it would conclude that Grangetown Prairie presented no significant risks to water resources. This risk was therefore excluded from the ROA. Confirmation of this assumption cannot be achieved until review of the DQRA is completed. Given the EA's concern about the quality of groundwater in the area, confirmation from the EA that they accept the findings of the DQRA is also required in order to close out this risk for the site.

Based on the CSM presented in Section 4 of this report, these risks are considered to be adequately reflective of risks identified at the site, in combination with the following elements that Arcadis identified as needing to be completed at a later stage:

- Further ground gas monitoring to be undertaken prior to the construction phase of any redevelopment;
- Assessment of post-remediation soil data against the UKWIR thresholds to select the appropriate classification of water supply pipes; and
- Completion of a PWRA.

[17] Arcadis (2020). Remediation Options Appraisal and Enabling Works and Remediation Strategy Report (DRAFT), Grangetown Prairie Area, Former Steelworks, Redcar, ref. 10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy.

[18] Arcadis (2021). Remediation and Earthworks Verification Report. TV ERF plot – Dorman Point, Teesworks. South Tees Development Corporation. 10035117-AUK-XX-XX-RP-ZZ-0351-03-TVERF_Verification.

5.2.2 UXO Risks

The Arcadis ROA and Strategy[17] noted that a Desktop UXO assessment has been completed for the Grangetown Prairie 'STDC boundary' which identified a Medium UXO risk for borehole and excavation works. Arcadis recommended that should redevelopment require the installation of piled foundations or deep ground improvement, clearance of locations for potential UXO should be undertaken. The exact design for the BA has not been finalised, but it is anticipated that piled foundations will be installed at the site and therefore this recommendation is considered to apply to the site. It is not known if the Detailed UXO Threat and Risk Assessment noted in Section 3.2 was undertaken and it has not been included in reports provided to Ramboll at the time of writing of this report. Therefore, it is not possible to comment on its findings in the context of contaminated land assessment.

5.3 Remediation and Re-Use Criteria Requirements

Sections 7.3.7 and 7.3.8 of the ROA and Strategy[17] present a set of Remediation Criteria and Re-Use Criteria as standards to which remediation must be undertaken to make Grangetown Prairie (including the BA site) suitable for a generic commercial/industrial use. That generic commercial/industrial use is taken by Arcadis as excluding the need for piled foundations and the associated potential contamination pathways to the deeper aquifer. Since piled foundations may be installed at the site a PWRA will be required to address the specie risks/ potential pathways that could be created. Samples taken from excavation extents, imported materials and site-won materials intended for re-use are required to meet the criteria for human health, water receptors and geotechnical suitability (in addition to containing no visible NAPL as far as reasonably practicable). These standards are detailed in Table 5-1.

Table 5-1: Summary of Remediation / Reuse Criteria (Arcadis)

Remediation Purpose	Remediation Criteria
Human health receptors (In order of priority)	LQM / CIEH Suitable for Use Levels (S4UL) (LQM / CIEH, 2015)
	DEFRA Category 4 Screening Levels (C4SL) (DEFRA, 2012)
	Arcadis-derived GAC based on CLEA v.1.07
	USEPA RSLs
	Wood-derived GAC based on CLEA v.1.07 for benzo(a)pyrene and naphthalene.
Water receptors	Remediation criteria to be defined by the DQRA
Accumulated NAPL	No visible NAPL to be recorded on groundwater or accumulated water as far as reasonably practicable
Geotechnical suitability	Backfill in line with the Highways Specification. Exact specification to be confirmed in Earthworks Specification.

It is noted that the Remediation Criteria for human health receptors adopted for the remediation are consistent with the GACs derived by Arcadis[3,5] for screening soil data at the site. Given that no greater contaminant risks have been identified at the site compared to the wider Grangetown Prairie, the Remediation Criteria for human health are considered to be appropriate to the site. Arcadis[17] note that the Wood-derived GACs for benzo(a)pyrene and the LQM S4ULs were agreed with the Regulatory Authority for Grangetown Prairie. These are also, therefore, considered appropriate for the site.

Remediation Criteria for water receptors are not specified in the ROA and Strategy, with reference instead being made to the DQRA, which had not been completed at the time of writing of the ROA and Strategy. The DQRA was not available for review at the time of writing this report. As such, until evidence that the DQRA has been completed and site Remediation Criteria set, it is not possible to comment on the suitability of the remediation to protect controlled waters.

Sections 7.3.7 and 7.3.8 of the ROA and Strategy[17] detail the compliance criteria (sampling frequency) to be undertaken from excavation extents, imported materials and site-won materials intended for re-use. Samples from each of these are required to pass the remediation criteria detailed in Table 5-1. Given that the ROA and Strategy has been completed for a generic commercial use with no proposed developments or site layout, this is understood to mean that all samples are required to pass the remediation criteria for human health, water receptors and geotechnical suitability, rather than select remediation criteria based on a proposed site layout. As such, this strategy is expected to be adequate for remediation of the site to the standard required for the proposed development (provided that verification sampling can be demonstrated to have been undertaken in line with the requirements of the DQRA and Earthworks Specification).

5.4 Remediation Activities

A summary of the enabling works and remediation activities being undertaken across the wider Grangetown Prairie site included in the Arcadis ROA and Strategy[17] is presented as Table 5-2.

Table 5-2: Summary of Remediation Activities

Remediation Activities*	Benefit
Enabling Works	
Removal and processing of relic underground structures and foundations for reuse, to a depth of 2.5 mbgl. The requirement to remove areas of deeper structures or foundations if encountered, to be assessed on a case by case basis.	Remove potential sources of risk to human health in soils across Grangetown Prairie (arsenic, asbestos, NAPL, cyanide) and improve geotechnical suitability of site for development
Screening and crushing of Made Ground materials in order to make suitable for re-use.	
Treatment of excavated soils impacted with NAPL in line with recommended processes identified within the ROA.	
Segregation of soils with ACM for treatment and reuse.	
Segregation and processing of refractory materials and potentially expansive slag deposits for re-use.	Remove potential contaminant source across Grangetown Prairie and improve geotechnical suitability of site for development
Dewatering of below-ground structures and excavations with management, treatment and disposal of water.	Net reduction of contaminated groundwater on site via off-site disposal.
Backfill of excavations to leave the site safe and level, with verified Made Ground, certified demolition arisings, crushed concrete or imported fill.	Restoration of site to foundation level following enabling works

Remediation Activities*	Benefit
Remediation	
Remediation of soils impacted with contaminants above Remediation Criteria through capping of materials to manage source-pathway receptor linkages	Removes pathway between residual contaminants in soils (if any remain following enabling works) and future site users

* All materials to comply with the Remediation Criteria listed in Table 5-1

A plan of maximum excavation depths anticipated to be undertaken by Arcadis[17] as part of the enabling works has identified the BA site to be excavated to 2.5 m bgl across the entire site.

Made Ground will be excavated, treated and replaced across the site as indicated in Table 5-2 and Plate 5.1. The potential ground contamination risks identified in the updated CSM presented as part of this report align with those identified across the wider Grangetown Prairie by Arcadis.

5.4.1 Remediation and Earthworks Verification - Energy Recovery Facility Site

The remediation and Earthworks Verification Report[18] was produced by Arcadis in relation to the enabling earthworks and remediation activities undertaken at the Dorman Point area of the Teesworks site. The purpose of the report was to present the verification of the works undertaken to ensure that they meet the agreed remediation objectives.

The "Site" as referenced within the verification report relates to a portion of the Dorman Point site which is proposed to become the adjacent Tees Valley Energy Recovery Facility (TV ERF) plot, and therefore does not include the BA site.

A remediation verification report for the BA site was not made available for review at the time of writing.

5.4.2 Issues Specific to the BA Site

Deep excavations

Should any excavation be required beyond the depth of the remediation, it is recommended that the excavation be undertaken in line with the Works approach detailed in Section 7.3 of the ROA and Strategy, in particular recommendations for groundwater management and unexpected contamination. A watching brief and validation sampling exercise should be undertaken during the deeper excavation in line with the compliance criteria outlined in Section 7.3.7 of the ROA and Strategy. Given limited data is present for deeper soils on the BA site, it is recommended that the excavated material be stockpiled on site and subject to chemical testing for the purposes of disposal off-site (if that is the intended destination of the excavated material). In the event that this material is to be re-used on site it should be screened against the compliance criteria outlined in Section 7.3.7 of the ROA and Strategy. In relation to dewatering of any required deeper excavations below the remediation level, given the widespread extent of contamination in soil and groundwater in both Made Ground and natural strata, and the general low permeability of strata on site and reported inconsistency in its occurrence, dewatering is not anticipated to cause movement of contamination into otherwise uncontaminated areas. Given the management, treatment and disposal of water removed from excavations detailed by the ROA and Strategy, this is expected to result in net reduction of contaminated groundwater on the site.

5.4.3 SuDS

For sustainable management of surface water runoff from a new development, the use of Sustainable urban Drainage Systems (SuDS) is recommended for the proposed development. The SuDS options potentially available for attenuating surface water runoff generated by the development of the site are presented in the Flood Risk Assessment and Drainage Strategy, which is submitted to RCBC as part of the outline planning application for the BA Facility.

Surface water runoff is likely to be restricted using SuDs features such as rainwater harvesting, attenuation ponds, permeable paving and/orgeo-cellular tanks with flow control installed at strategic points before discharging into the Holme Beck culvert. However, specific forms of SuDS and attenuation cannot be determined at this time until further site details are confirmed.

It is recommended that excavations undertaken during construction of the any SuDS should be undertaken following the completion of the enabling works outlined by the ROA and Strategy[17]. This should be undertaken in line with the Works approach detailed in Section 7.3 of the ROA and Strategy, in particular recommendations for groundwater management and unexpected contamination. A watching brief and validation sampling exercise should be undertaken during the excavation of the SuDS in line with the compliance criteria outlined in Section 7.3.7 of the ROA and Strategy. Provided that the upper approximately 2.5 m of soil is remediated to the Water Resources compliance criteria to be confirmed by the Arcadis DQRA as required by Section 7.3 of the ROA and Strategy, it is expected that the potential for leaching of additional contaminants to groundwater via the SuDS will be minimised.

5.4.4 Piled Foundations

The Arcadis Phase 2 Environmental Assessment recommended that in the event that piled foundations would form part of a future development, a PWRA should be prepared to assess the potential risks to groundwater from preferential pathways created by piled foundations. Later assessment undertaken by Arcadis discounted groundwater as a sensitive receptor and the ROA and Strategy[17] did not include requirements for a PWRA. It is noted however that the ROA and Strategy was prepared for a generic commercial land use with no piled foundations.

It is expected that the proposed development may include piled foundations and it is recommended that a PWRA should be prepared for the proposed development. This may be used to demonstrate that the piled foundations will create no significant risk of contaminant migration in groundwater, and fulfil the EA requirement for appropriate investigation and assessment of the groundwater environment.

5.4.5 Post-Enabling Works Remedial Actions

The ROA and Strategy[17] does not include ground gas monitoring but recommends additional ground gas monitoring to be undertaken prior to any specific redevelopment at the site (but after the completion of enabling works) however notes that this would be the responsibility of the developer. The ROA and Strategy does not give reference to drinking water supply pipes, however it is noted that these would typically be installed as part of a specific development's construction works. As such, any further assessment of suitability of the site for plastic drinking water supply pipes would likely need to be undertaken after the completion of enabling works (or barrier pipe or similar material used instead).

5.5 Verification Requirements

Ramboll understands that at the time of writing this report, the enabling works detailed in the ROA and Strategy[17] are underway and have been completed at the wider Grangetown site. At the time of writing, aside than for the adjacent ERF site,no verification records or documentation of the progress of enabling works in the wider Grangetown Prairie area or at the BA site are available to review.

In order to confirm completion of the enabling works and remediation at the site, a remediation works verification report is required to be prepared for wider Grangetown Prairie area, and in particular the BA site. Requirements for this report are set out in Section 8.3 of the Arcadis ROA and strategy document and will be based on a number of lines of evidence documented through the implementation phase. These lines of evidence are as follows:

- Field Records, including:
  - Excavation extents and depths supported by topographic survey data;
  - Field Screening / on-site analysis of soil samples;

  - Volumetric records of water and free phase hydrocarbons recovered from excavations; and
  - Photographic records of the works.
- Soil and water laboratory analysis data, demonstrating that:
  - On completion of excavations contaminant concentrations within remaining in-situ soil meet the re-use criteria as far as is reasonably practicable;
  - Contaminant concentrations within excavated soil that may be re-used on site as infill to excavations, meet the re-use criteria; plus
  - Laboratory analysis of recovered groundwater / treated groundwater to support off-site disposal, re-infiltration or disposal under consent to foul drainage network; and
  - Laboratory analysis results of material imported onto site as backfill to demonstrate material meets the reuse criteria.
- Site drawings and topographic plans, demonstrating;
  - Source areas have been removed and provide record of excavation extents during the works;
  - Records of below-ground obstructions left in-situ following the works;
  - Site levels have been restored to the agreed formation levels;
  - Thickness and extent of capping layer placed on the site; and
  - Re-used materials have been located in the correct place through as-built drawings showing locations of remedial works and records of residual hazards.
- Materials audit trail records and environmental monitoring, demonstrating that:
  - Re-used material has been deposited in the correct location in compliance with the materials management plan;
  - Waste materials have been properly quantified and have been accepted by an appropriately licensed facility including completed waste transfer documentation; and;
  - Imported materials are of correct quality and volume for use on site and free of asbestos.

5.6 Appropriateness of Remediation Works

The remediation works which have been undertaken and are now understood to be complete at Grangetown Prairie as outlined by the ROA and Strategy[17], are considered to generally be appropriate and relevant to address the risks identified at the site, however it is noted that verification information was not available for review..

However, in addition to the works being carried out, the ROA and Strategy notes a number of additional measures that are beyond the scope of the ROA and will require addressing as part of the site-specific development. The ROA and Strategy also does not document the Remediation Criteria for the protection of controlled waters and thus it is not currently possible to confirm the appropriateness of the criteria used, and thus if they are also appropriate for the site. The additional measures and data gaps are discussed further in Section 5.7.

5.7 Data/Assessment Gaps

A summary of the identified data gaps still outstanding at remediation stage and works needed on a site-specific basis are presented in Table 5-3.

Table 5-3 Data Gaps and Further Works

Data Gap	Remedial Action Required
Gaps in Current Remediation Activities/Documentation	
ROA does not document Remediation Criteria for protection of	Remediation criteria to be defined by the DQRA. Confirmation of suitability to be completed once document received. DQRA to be approved by the EA, who (based upon reports provided to Ramboll) have stated that they did not consider the risk to controlled waters at Grangetown Prairie (including the BA site) to be acceptable without appropriate investigation and assessment.

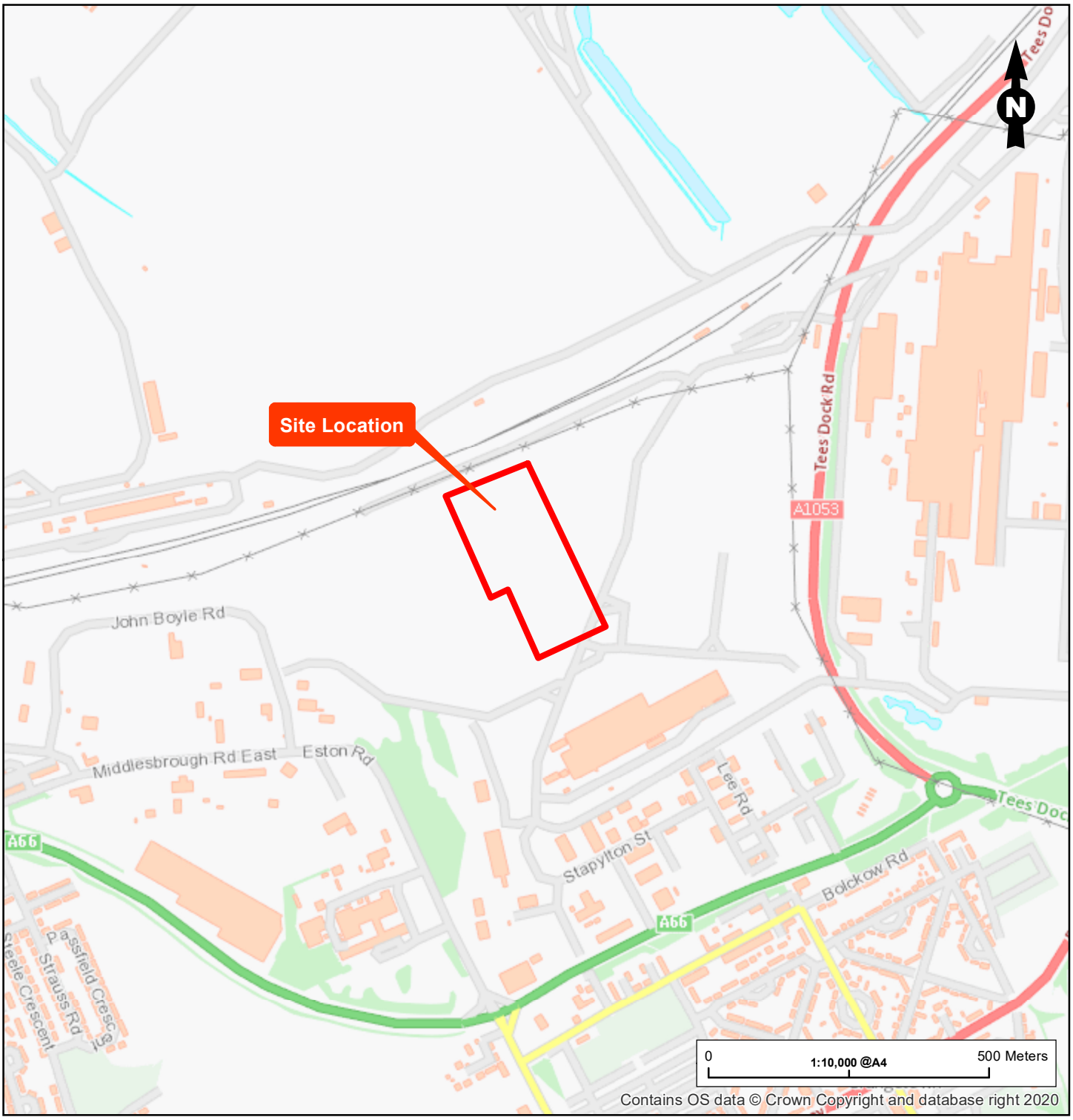
Data Gap	Remedial Action Required
controlled waters.	This requirement may have been dealt with under the documentation submitted to RCBC in order to have gained discharge of condition 5 for the ERF site.
Verification documentation to prove compliant and successful remediation of the site	Following the remediation of the site, a verification report providing documented evidence of the works as detailed in Section 5.3 will be required to confirm that remediation works have been undertaken on the BA site in line with the ROA and Strategy[17] (including remediation criteria defined by the DQRA). At the time of writing, no verification report or associated documentation relating to the BA site has been reviewed by Ramboll. This requirement may have been dealt with under the documentation submitted to RCBC in order to have gained discharge of condition 5 for the ERF site.
Issues to be Addressed for the BA Site Following Completion of Generic Remediation	
Ground gas status and level of protection required (if any)	Ground gas monitoring scoped out of ROA and Strategy. To be undertaken following the completion of remediation works and prior to the construction of the proposed BA facility. Monitoring will require installation of monitoring installations (unless any remain following remediation). A ground gas assessment demonstrating that the ground gas regime at the site correlates to CS1 conditions (or that suitable ground gas protection has been selected and incorporated into the buildings of the proposed development) will be required.
ROA assumes no piled foundations or deep basements required	A PWRA should be undertaken for the proposed development upon receipt of specific piling design details to confirm no significant risk of contaminant migration in groundwater via preferential pathways. The PWRA will need to be submitted to the local planning authority in order to support signing off of planning conditions associated with contaminated land.
Potable water supply pipe specification	Soil verification sampling results to be screened against UKWIR thresholds to confirm suitability of PE plastic drinking water supply pipes at the site (or barrier pipe or similar should be selected for use). This requirement may have been dealt with under the documentation submitted to RCBC in order to have gained discharge of condition 5 for the ERP site.
Management of risks to groundwater during excavation of deep structures (if relevant)	To be completed in line with the Works approach detailed in Section 7.3 of the ROA and Strategy, in particular recommendations for groundwater management and unexpected contamination (anticipated to comprise watching brief records demonstrating no NAPL presence in the excavations, laboratory test results from excavation extents which meet the remediation criteria and laboratory testing and re-use / waste disposal records for soil and groundwater removed from the excavations)
SuDS	As per the deep excavations, depending upon depth and groundwater levels at required locations
UXO	The ROA and Strategy notes that the site is medium UXO risk for borehole and excavation works. Arcadis recommended that should redevelopment require the installation of piled foundations or deep ground improvement or excavations, that clearance of locations for potential UXO should be undertaken. The Detailed UXO Threat and Risk Assessment has not been included in reports provided to Ramboll to review so the exact implications of UXO on deep foundations cannot be detailed at this time. This may or may not be needed, and specialist advice should be sought.
Unexpected contamination	Unexpected contamination protocol within the ROA and Strategy to be adopted for all groundworks to be completed on the site.

6. CONCLUSIONS AND RECOMMENDATIONS

The Phase 1 and Phase 2 ground investigation works undertaken at the site indicate that the potential risks to human health and controlled waters with respect to ground contamination are generally comparable with those of the wider Grangetown Prairie site (with lower risk to off-site receptors due to the increased distance to such receptors from the site). The remediation works specified within the ROA and Strategy are considered to be appropriate to the remediation of the site for a generic commercial land use. A number of potential data gaps have been identified, which are being addressed by risk assessments and remediation works, as discussed in Section 5.7.

A verification report presenting evidence of remediation of the wider Grangetown Prairie area (and including the BA site specifically) should be completed by others in accordance with the requirements of the Remediation Strategy and submitted to RCBC. Once this is completed, a supplementary verification report presenting site-specific verification information as detailed in Table 5-3 should be submitted to RCBC to demonstrate that remedial works at the site are appropriate to the proposed BA development.

APPENDIX A
SITE LOCATION



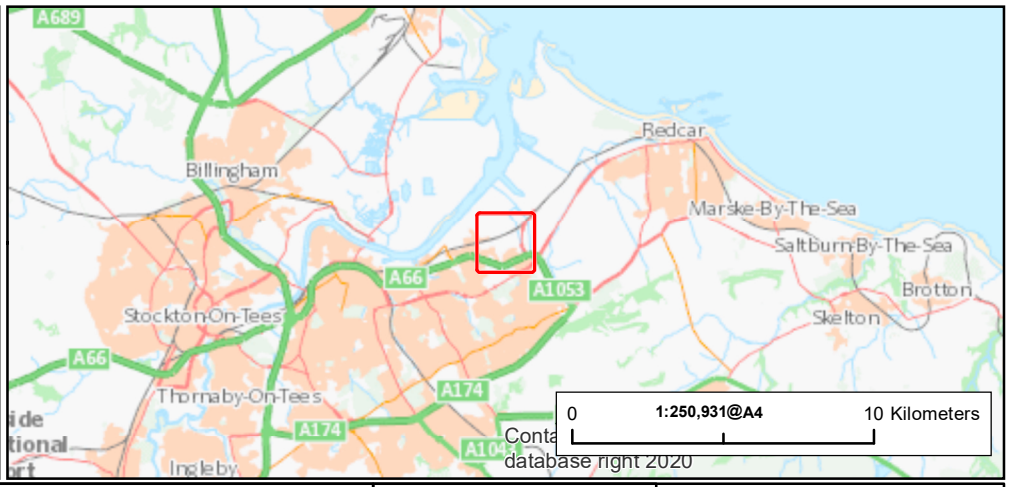


Figure Title: Figure 1: Site Location	Project Name: Tees Valley BA	Date: March 2022	
		Scale: As shown	
Project Number: 1620013801	Client: Viridor Waste Ltd	Issue: 2	Prepared By: DP

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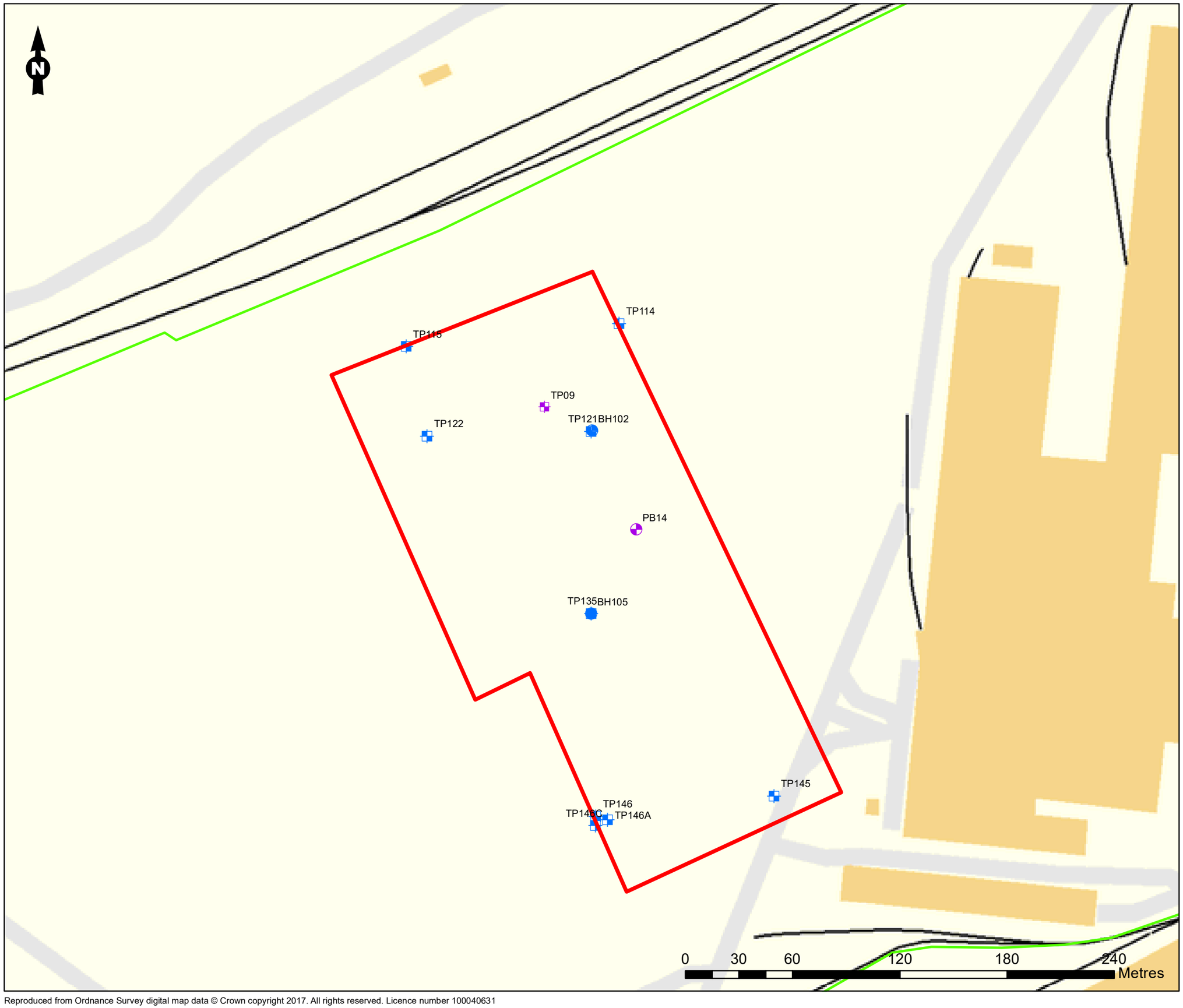
Coordinate System: British National Grid. Projection: Transverse Mercator. Datum: OSGB 1936.

APPENDIX B
EXPLORATORY HOLE LOCATION PLAN



Legend

- Grangetown Prairie Boundary
- BA Site Location
- Borehole
- Trial Pit
- Borehole
- Trial Pit

Locations are indicative only.
Not to scale.

Colour drawing.

Figure Title	Exploratory Hole Location Plan
Project Name	Tees Valley BA
Project Number	1620013801
Figure No.	2
Date	March 2022
Prepared By	BK
Scale	1:2,000 @A3
Issue	02
Client	**Viridor Waste Limited**

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APPENDIX C
LEGISLATIVE CONTEXT

LEGISLATIVE CONTEXT

England

The regime for contaminated land was set out in Part 2A (ss.78A-78YC) of the Environmental Protection Act 1990 (EPA), as inserted by S.57 of The Environment Act 1995 and came into effect in England on 1st April 2000 as The Contaminated Land (England) Regulations 2000 (SI 2000/227). These regulations were subsequently revoked with the provision of The Contaminated Land (England) Regulations 2006 (SI 2006/1380) (as amended), which came into force in August 2006, and consolidated the previous regulations and amendments. Revised statutory guidance ("the Guidance") for local authorities on how to implement the regime, including the decision-making process on whether land is contaminated land in the legal sense, has been published by Defra and entered into force in April 2012.

Under Part 2A of the EPA Section 78A(2), "contaminated land" is defined as "land which appears… to be in such a condition, by reason of substances in, on or under the land, that:

a) significant harm is being caused or there is a significant possibility of such harm being caused[1]; or
b) significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused".

"Significant harm" is defined in the Guidance on risk-based criteria and must be the result of one or more relevant 'contaminant linkages' relating to the land. The presence of a contaminant linkage relies on the Source-Pathway-Receptor concept, where all three factors must be present and potentially or actually linked for a potential risk to exist. Under the Guidance, a 'significant contaminant linkage' is one which gives rise to a level of risk sufficient to justify a piece of land being determined as contaminated land. Should the authority consider that there is an unacceptably high probability, supported by robust science-based evidence that significant harm would occur if no action is taken to stop it, the land should be deemed a Category 1: Human Health. Land should be placed into Category 2 if the authority concludes, on the basis that there is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm. Both Category 1 and Category 2 cases would be capable of being determined as contaminated land under Part 2A on the grounds of significant possibility of significant harm to human health. If the legal test for significant possibility of significant harm is not met, the authority should place the land into Category 3. If the local authority considers that there is no risk or that the level of risk posed is low, the land should be placed into Category 4.

For six common contaminants (benzo(a)pyrene, cadmium, arsenic, benzene, hexavalent chromium and lead), a set of screening values have been developed and endorsed for use by Defra[2] (the Category 4 Screening Levels, or C4SLs) that describe a level of risk just below the Category 3/4 boundary set in the Statutory Guidance, i.e. where concentrations are below the C4SL, there is no risk or the level of risk is acceptably low. The Environment Agency states under their Land Contamination Risk Management (LCRM)[3] approach that they expect C4SL values to be used in risk assessments for land contamination.

The pollution of controlled waters is defined in Section 78A(9) of the Act as "the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter". The new Guidance stresses that the Part 2A regime is designed to identify and deal with 'significant pollution' and not lesser levels of pollution. As with human health risk, Categories 1 and 2 comprise land where the

[1] Water Act 2003 (Commencement No. 11) Order 2012
[2] SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document, Defra, revised December 2014
[3] Environment Agency (2020) Land Contamination Risk Management

local authority considers that a significant possibility of significant pollution of controlled waters exists and Categories 3 and 4 comprises cases where the authority considers that a significant possibility of such pollution does not exist. The local authority should be satisfied that a substance is continuing to enter controlled waters or is likely to enter controlled waters.

Risk Assessment Framework

"Significant harm" or "significant pollution of controlled waters" is defined in the Guidance on risk-based criteria and must be the result of one or more relevant 'contaminant linkages' relating to the land.

The presence of a contaminant linkage relies on the Source-Pathway-Receptor concept, where all three factors must be present and potentially or actually linked for a potential risk to exist. For a risk of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A source - a substance that is capable of causing pollution or harm;
- A receptor - something which could be adversely affected by the contaminant; and
- A pathway - a route by which the contaminant can reach the receptor.

If one of these elements is absent there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

The Land Contamination: Risk Management[4] (LCRM) provides the technical framework for structured decision making about land contamination. LCRM advocates a phased approach, commencing with Stage 1 Risk Assessment comprising:

- Preliminary Risk Assessment (PRA) – desk study and qualitative assessment to develop of an outline Conceptual Site Model (CSM);
- Generic Quantitative Risk Assessment (GQRA) – an estimation of risk through assessment of contaminant concentrations against generic assessment criteria; and
- Detailed Quantitative Risk Assessment (DQRA) – an estimation of risk through detailed site-specific risk assessment and development of site-specific assessment criteria (SSAC) and site-specific risk assessment.

Each stage of assessment is focussed upon the development and refinement of a conceptual site model, which identifies Source-Pathway-Receptor linkages. The conceptual site model has been developed with consideration to guidance including BS EN ISO 21365:2020 Soil quality – Conceptual site models for potentially contaminated sites.

RISK ESTIMATION

An assessment of environmental risks is made for each potential pollutant linkage identified.

Risk estimation has been completed in accordance with the guidance provided in:

- NHBC and Environment Agency 2008. Guidance for the Safe Development of Housing on Land Affected by Contamination. R&D Publication 66: 2008.

The following is taken directly from NHBC/EA 2008. The key to the classification is that the designation of risk is based upon the consideration of both:

[4] Land Contamination: Risk Management (LCRM), published by the Environment Agency on 8 October 2020

- the magnitude of the potential consequence (i.e. severity) [takes into account both the potential severity of the hazard and the sensitivity of the receptor]; and
- the magnitude of probability (i.e. likelihood) [takes into account both the presence of the hazard and receptor and the integrity of the pathway].

Table 1: Classification of Consequence (after NHBC/EA 2008)

Category	Definition
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.
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.
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.
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.

* 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.

The likelihood of an event (probability) takes into account both the presence of the hazard and target and the integrity of the pathway and has been assessed based on the categories given below.

Table 2: Classification of Probability (after NHBC/EA 2008)

Category	Definition
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.

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.
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.
Unlikely	There is pollutant linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term.

The potential severity of the risk and the probability of the risk occurring have been combined in accordance with the following matrix in order to give a level of risk for each potential hazard.

Table 3: The Classification of Risk (after NHBC/EA 2008)

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	**Very high**	High	Moderate	Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/ Low	Low	Very low
	Unlikely	Moderate/ Low	Low	Very low	Very low

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.

APPENDIX D
PROPOSED SITE PLAN

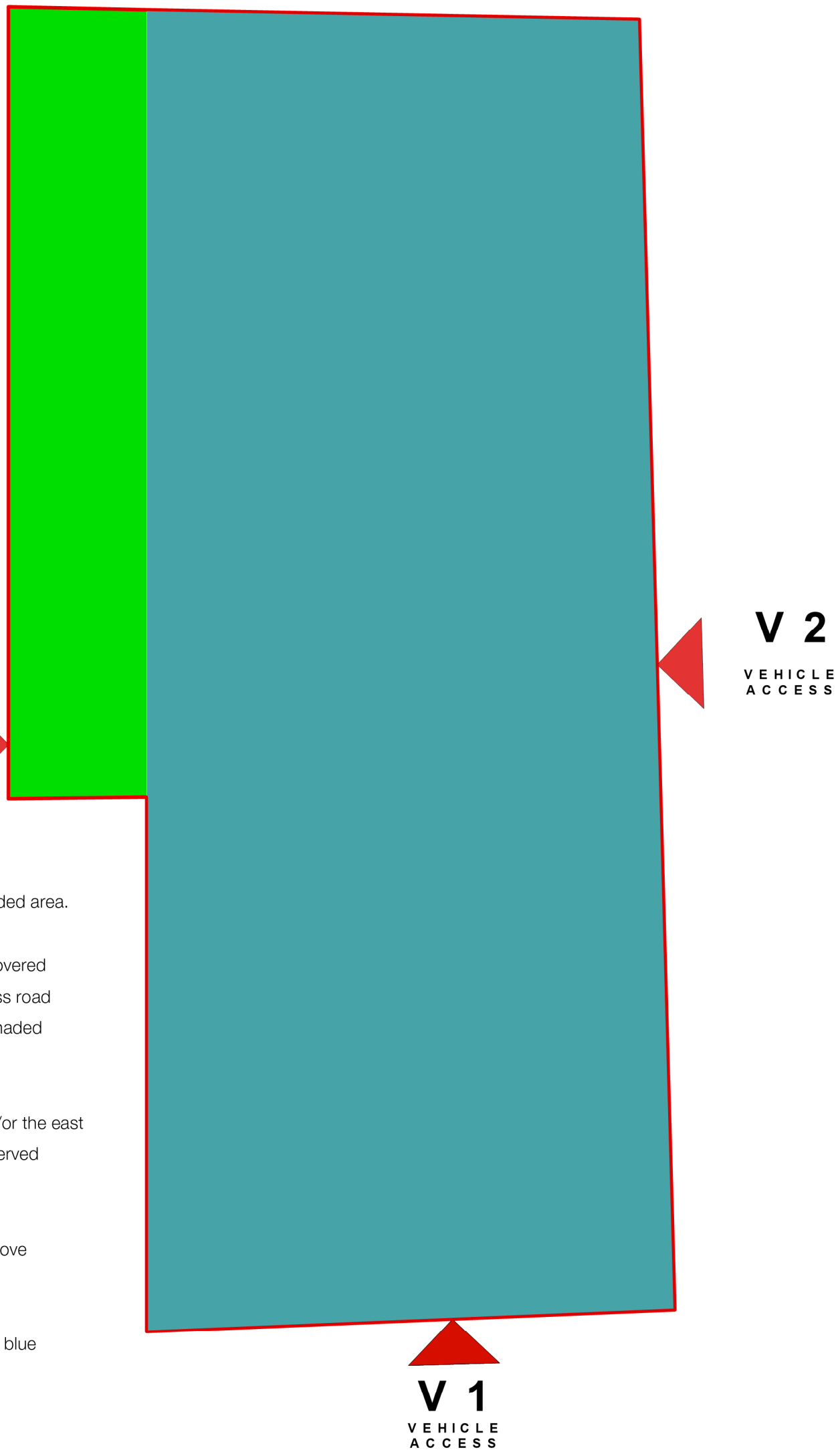
KEY

Application site boundary

Area of main building zone (circa 4.07ha)

ERF BA delivery zone (circa 0.67ha)

Vehicle access



BA development to be located in the blue shaded area.

The arrow at C indicates access either via a covered conveyor (max 10 m wide) or an internal access road from the adjacent ERF site through the area shaded green.

Vehicular accesses will be from the south and/or the east (V1/V2), exact location to be addressed at reserved matters.

Development will not exceed 16m in height above ground across the blue shaded area.

The total footprint of covered floorspace in the blue shaded area will not exceed 13,000sqm.

1 Parameter plan
Scale: 1:1250

Tees Valley BA Facility

Viridor

0 10 20 30 40 m

Scale to be used for planning purposes only

Parameter Plan

227707C -TOR-XX-ZZ-DR-A-P004 -

Scale @ A3: 1:1250 PLANNING

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TERENCE O'ROURKE