TEESWORKS

DORMAN POINT ENVIRONMENTAL STATEMENT

VOLUME 2: CHAPTER H
GROUND CONDITIONS AND REMEDIATION

DECEMBER 2020

Dorman Point, South Tees

Volume 2: Environmental Statement (December 2020)

Chapter H: Ground Conditions and Remediation

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Contents

H1.0 Introduction

H1.1 This chapter of the Environmental Statement ('ES') has been prepared by Arcadis (UK) Ltd on behalf of the applicant, South Tees Development Corporation ('STDC'). It assesses the proposed development described in Chapter B and it considers the effects of the proposed development on the site's ground conditions and the need for remediation.

H1.2 The baseline situation has been considered before the potential environmental effects of the proposed development are identified during the construction phase of the development. The operational phase of the development has been scoped out in relation to ground conditions and remediation, the rationale for which is provided in Chapter A of the ES and Section H3.5 – H3.15 of this chapter. Mitigation measures to reduce any adverse environmental effects are identified as appropriate, before the residual environmental effects are assessed.

H1.3 This Chapter is supported by the following technical appendices: -

1 **Appendix H1**: Grangetown Prairie Area, Former Steelworks, Redcar, Detailed Conceptual Site Model Review and Risk Assessment, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment dated July 2020 [Arcadis 2020 H1];

2 **Appendix H2**: Regulatory Liaison with Redcar and Cleveland Borough Council (RCBC H2);

3 **Appendix H3**: Site Layout (POD 2020 H3)

4 **Appendix H4**: Grangetown Prairie Area, Former Steelworks, Redcar, Remediation Options Appraisal (ROA), Enabling Earthworks and Remediation Strategy Report, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0066-01-Praire ROA and Strategy dated June 2020 [Arcadis 2020 H4];

5 **Appendix H5**: Grangetown Prairie Area, Former Steelworks, Redcar, Phase II Environmental Site Assessment, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0062-02-Prairie_ESA, dated June 2020 [Arcadis 2020 H5];

6 **Appendix H6**: Grangetown Prairie Area, Former Steelworks, Redcar, Phase II Environmental Site Assessment - Addendum, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0117-02-Prairie_ESA Addendum, dated November 2020 [Arcadis 2020 H6];

7 **Appendix H7**: The Former SSI Steelworks, Redcar: Priority areas within SSI Landholdings Contract 3, Site Condition Report, Prepared for South Tees Site Company by Arcadis, Ref Redcar Steelworks-AUK-XX-XX-RP-GE-0001-02-SSI3_GI_SCR, dated August 2018 [Arcadis 2018 H7];

8 **Appendix H8**: The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract 3, Environmental Risk Assessment Report, Prepared for South Tees Development Corporation by Arcadis, Redcar Steelworks-AUK-XX-XX-RP-GE-0001-01-SSI3_GI_ERA, dated August 2018 [Arcadis 2018 H8];

9 **Appendix H9**: Grangetown Prairie Site, Redcar, Earthworks Specification, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0171-01-Earthworks_Spec, dated September 2020 [Arcadis 2020 H9];

10 **Appendix H10**: The Former SSI Steelworks, Redcar: Priority areas within SSI Landholdings Contract 3, Geotechnical Risk Assessment Report, Prepared for South Tees

Development Corporation by Arcadis, Ref Redcar Steelworks-AUK-XX-XX-RP-GE-0001-P1-SSI3_GI_GRA, dated November 2018 [Arcadis 2018 H10];

11 **Appendix H11**: The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract 3, Ground Remediation Options Appraisal Report, Prepared for South Tees Development Corporation by Arcadis, Redcar Steelworks-AUK-XX-XX-RP-GE-0001-01-SSI3_GI_ROA, dated December 2018 [Arcadis 2018 H11];

12 **Appendix H12**: The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract 3, Final Factual Report, Prepared for South Tees Development Corporation by Allied Exploration & Geotechnics Ltd (AEG), Ref 4155, dated June 2018 [AEG 2018 H12];

13 **Appendix H13**: 4251 - Prairie Site Ground Investigation Works (Final Report r01), Prepared for South Tees Development Corporation by Allied Exploration & Geotechnics Ltd (AEG), Ref 4251, dated November 2020 [AEG 2020 H13];

14 **Appendix H14**: Eston Road Intrusive Works, Final Factual Report (Rev. 00), Prepared for South Tees Development Corporation by Allied Exploration & Geotechnics Ltd (AEG), Ref 4287, dated November 2020 [AEG 2020 H14];

15 **Appendix H15**: Soil and Groundwater Baseline Characterisation Study, Teesside Works, prepared by Enviros for Corus UK Ltd [Enviros 2004 H15], Comprising:

- i Volume 1 – Factual Report, Ref. Rlp250604corusteessidefactual.Doc dated 25th June 2004 and marked Final;
- ii Volume 2 – Interpretive Report Ref. Mwicorusdraftinterpretivemmdv#2.Doc dated 25th June 2004 and marked Final; and,
- iii Volume 3 – Summary Report dated June 2004.

16 **Appendix H16**: Phase 1 Environmental Review, Corus Cleveland Prairie Teesside Site, prepared by Enviros for Graphite Resources, Ref GR1280001, Draft Report, August 2007 [Enviros 2007 H16];

17 **Appendix H17**: Phase 2 Geo-environmental Assessment, Corus Cleveland Prairie Teesside Site, prepared by Enviros for Graphite Resources, Ref GR1280001, Final Report, March 2008 [Enviros 2008 H17];

18 **Appendix H18:** TS3 Grangetown Prairie – Phase 1 Geo-environmental Desk Study, prepared by CH2M Hill UK (CH2M) for Homes and Communities Agency, Ref. 678079_TS3_001, August 2017 [CH2M 2017 H18];

19 **Appendix H19**: Former Corus Cleveland Prairie Site: Land off Clay Lane, Ground Investigation Report, prepared by MD2 for ONE North East, Ref. MD2_113, July 2011 [MD2 2011 H19];

20 **Appendix H20**: Prairie Site: Land off Clay Lane, Ground Investigation Factual Report, prepared by Shadbolt Environmental LLP for ONE North East, July 2011 [Shadbolt 2011 H20];

21 **Appendix H21**: Site 1 (Dorman Point) Redcar, North East England, TS10 1DZ, Enviro + Geo Insight Report, prepared by Groundsure for Arcadis, Ref: GS-7224470, 4th November 2020 [Groundsure 2020 H21];

22 **Appendix H22**: Former Steelworks Land, South Tees Outline Remedial Strategy, Prepared for South Tees Development Corporation by Wood, Ref 41825-wood-XX-XX-RP-OC-0001_S0_P01 dated 25th June 2019 [Wood 2019].

About the Author

H1.4 This chapter has been prepared by Jake Hurst BSc (Hons), MSc, CEnv, Principal Consultant Arcadis UK Ltd. Jake has over 15 years' experience in contaminated land assessment, chemical analysis and remediation including the preparation of Environmental Statements for Environmental Impact Assessments (EIA) and other regulatory, permitting and planning support across a range of commercial, industrial and residential development projects.

H1.5 The chapter has been reviewed by Chris Piddington PhD, BEng (Hons), Technical Director Arcadis UK Ltd. Chris has over 18 years' experience in delivering bespoke contaminate dland solutions and brownfield regeneration schemes. His work includes the preparation of Environmental Statements to support Environmental Impact Assessments in addition to providing support and guidance in relation to regulatory, permitting and planning challenges across a diverse range of development projects.

H1.6 Arcadis is a member of the IEMA EIA Quality Mark.

H2.0 Policy Context

National Policies and Legislation

H2.1 The legislation, policy and documentation applicable to Land Quality and Soil Contamination at the national level are listed in Section H10 (References) of this chapter and shown below. These documents are used to guide the assessment of potential risks posed by contamination, the significance of potential impacts as well as to inform mitigation measures in line with industry good practice.

1 Environmental Protection Act 1990 Part II (Ref 1);

2 Environment Act 1995 (Ref 2);

3 Environment Agency 2008, An ecological risk assessment framework for contaminants in soil. Science Report SC070009/SR1 (Ref 3);

4 Derivation and use of soil screening values for assessing ecological risks Report – ShARE id26 (revised) (Ref 4);

5 BRE Special Digest (SD) 1: Concrete in Aggressive Ground, 2015 (Ref 5);

6 Environmental Permitting (England and Wales) Regulations 2010 (Ref 6);

7 Control of Pollution (amendment) Act 1989 (Ref 7);

8 Water Framework Directive 2000/60/EC (Ref 8);

9 Groundwater Directive 2006/118/EC (Ref 9);

10 Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991 (as amended) (Ref 10);

11 Controlled Waste (England and Wales) Regulations 2012 (Ref 11);

12 Construction (Design and Management) Regulations 2015 (Ref 12);

13 Hazardous Waste (England and Wales) Regulations 2005 (Ref 13);

14 Waste (England and Wales) Regulations 2011 (Ref 14);

15 Waste Framework Directive 2008/98/EC (OJEU, 2008) (Ref 15);

16 The Contaminated Land (England) Regulations 2006 (Ref 16);

17 The Environment Damage (Prevention and Remediation) Regulations 2015 (Ref 17);

18 National Planning Policy Framework, 2019 (Ref 18);

19 Environment Agency, Guiding Principles Land Contamination (GPLC2) (Ref 19)

20 Environment Agency, Land Contamination Risk Management (2019) (Ref 20);

21 Environment Agency, Land contamination groundwater compliance points: quantitative risk assessments, 2017 (Ref 21);

22 Environment Agency, Protect groundwater and prevent groundwater pollution, 2017 (Ref 22);

23 Environment Agency, Groundwater protection technical guidance, 2017 (Ref 23);

24 Environment Agency, The Environment Agency's approach to groundwater protection, 2018 (Ref 24);

25 British Standards 10175:2011+A2:2017 'Investigation of Potentially Contaminated Sites - Code of Practice' 2017 (Ref 25);

26 British Standards BS3882:2015 'Specification for Topsoil and Requirements for Use' 2015 (Ref 26);

27 British Standards BS EN 206:2013+A1:2016 'Concrete - Specification, Performance, Production and Conformity' 2013 (Ref 27);

28 BSI Standards Publication "Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings", BS 8485:2015+A1:2019 (Ref 28);

29 CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings' 2007 (Ref 29);

30 CIRIA C552 Contaminated Land Risk Assessment A Guide to Good Practice. 2001 (Ref 30);

31 CIRIA C692 Environmental Good Practice on Site. 4th Edition 2015 (Ref 31);

32 National House Building Council, Environment Agency and Chartered Institute of Environmental Health 'R&D Pub 66: Guidance for the Safe Development of Housing on Land Affected by Contamination (Volumes 1 & 2), 2008 (Ref 32);

33 National House Building Council, Guidance on Evaluation of Development Proposal on Site Where Methane and Carbon Dioxide are Present Report Edition No.4 March 2007 (Ref 33);

34 EA's 'TR P5-065/TR: Technical Aspects of Site Investigation (Volumes 1 & 2)' 2002 (Ref 34);

35 DEFRA (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance; and DEFRA Guidance, Pollution Prevention for Businesses, July 2016 (Updated May 2019) (Ref 35).

National Planning Policy

H2.2 The National Planning Policy Framework (NPPF) 2019 sets out the Government planning policies for England and how these are to be applied. Chapter 11 (Making effective use of land) and Chapter 15 (Conserving and enhancing the natural environment) of the NPPF - contain the following paragraphs which are relevant to this assessment and are summarised below:

H2.3 Paragraph 117 states that "Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land";

H2.4 Paragraph 118 (c) states that "planning policies and decisions should give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land".

H2.5 Paragraph 170 requires that the planning policies and decisions should "contribute to and enhance the natural and local environment by: (a) protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils; (b) recognising...the wider benefits from natural capital and ecosystem services...; (d) minimising impacts on and providing net gains for biodiversity...; (e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability...; and (f) by remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate".

H2.6 Paragraph 178 requires that "planning policies and decisions should ensure that: (a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well

as potential impacts on the natural environment arising from that remediation); (b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and (c) adequate site investigation information, prepared by a competent person, is available to inform these assessments".

H2.7 Paragraph 179 states that "where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner".

H2.8 Guidance from the Ministry of Housing, Communities & Local Government includes online planning policy guidance on 'Land affected by contamination' (2019) and 'Land stability' (2019).

Local Planning Policy

H2.9 Redcar and Cleveland Borough Council (RCBC) will determine the outline planning application in accordance with Section 38(6) of the Planning and Compulsory Purchase Act 2004, which states that planning applications must be made in accordance with the development plan u nless material considerations indicate otherwise.

H2.10 In this case, the relevant statutory development plan comprises:

1 Redcar and Cleveland Local Plan (adopted May 2018);

2 Local Plan Policies Map; and

H2.11 The Tees Valley Joint Minerals and Waste Development Plan Documents, comprising:

1 Minerals and Waste Core Strategy DPD (adopted September 2011); and

2 Minerals and Waste Policies and Sites DPD (adopted September 2011).

H2.12 Planning policies relevant to ground conditions and remediation associated with the proposed development are set out below.

H2.13 Local Plan Policy LS 4 (South Tees Spatial Strategy) includes the following aims in relation to the environment:

1 enhance the environmental quality of employment through well planned boundary treatments;

2 secure decontamination and redevelopment of potentially contaminated land;

3 protect European sites, and safeguard and improve sites of biodiversity interest particularly along the River Tees and the estuary and encourage integrated habitat creation and management;

4 enhance the environmental quality of the River Tees and coastline;

5 encourage improvements to access, interpretation and wildlife conservation and biodiversity across the area.

H3.0 Assessment Methodology & Significance Criteria

Assessment Methodology

H3.1 The assessment of impacts to and from the existing ground conditions and from the proposed development is undertaken using importance and significance criteria that have been developed by Arcadis, and successfully applied to other Environmental Impact Assessments. The methodology considers the potential presence of land and groundwater contamination as well as sites of geological/geomorphological significance such as geological conservation features or mineral resources and the potential effects on identified human health and environmental receptors. Geotechnical constraints e.g. differential settlement, subsidence and the potential for explosive ground gas accumulation are also highlighted with the built environment identified as the main sensitive receptor. The built environment includes foundations, below-ground structures, utilities equipment and buildings.

H3.2 The reports listed below (listed as appendices in paragraph H1.3 above) and an up to date GroundSure Report (Report Ref: GS-7224470, November 2020) have been used to establish the baseline conditions. The Conceptual Site Model (CSM) presented in the Detailed Conceptual Site Model Review and Risk Assessment (Arcadis 2020 H1), is integrated into the baseline conditions. All supporting information is consistent with the risk-based framework adopted by the Environment Agency: Land Contamination Risk Management (2020).

1 Grangetown Prairie Area, Former Steelworks, Redcar, Detailed Conceptual Site Model Review and Risk Assessment, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment dated July 2020 [Arcadis 2020 Appendix H1];

2 Grangetown Prairie Area, Former Steelworks, Redcar, Remediation Options Appraisal (ROA), Enabling Earthworks and Remediation Strategy Report, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0066-01-Praire ROA and Strategy dated June 2020 [Arcadis 2020 Appendix H4];

3 Grangetown Prairie Area, Former Steelworks, Redcar, Phase II Environmental Site Assessment, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0062-02-Prairie_ESA, dated June 2020 [Arcadis 2020 Appendix H5];

4 Grangetown Prairie Area, Former Steelworks, Redcar, Phase II Environmental Site Assessment - Addendum, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0117-02-Prairie_ESA Addendum, dated November 2020 [Arcadis 2020 Appendix H6];

5 The Former SSI Steelworks, Redcar: Priority areas within SSI Landholdings Contract 3, Site Condition Report, Prepared for South Tees Site Company by Arcadis, Ref Redcar Steelworks-AUK-XX-XX-RP-GE-0001-02-SSI3_GI_SCR, dated August 2018 [Arcadis 2018 Appendix H7];

6 The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract 3, Environmental Risk Assessment Report, Prepared for South Tees Development Corporation by Arcadis, Redcar Steelworks-AUK-XX-XX-RP-GE-0001-01-SSI3_GI_ERA, dated August 2018 [Arcadis 2018 Appendix H8];

7 Grangetown Prairie Site, Redcar, Earthworks Specification, Prepared for South Tees Development Corporation by Arcadis, Ref 10035117-AUK-XX-XX-RP-ZZ-0171-01-Earthworks_Spec, dated September 2020 [Arcadis 2020 Appendix H9];

8 The Former SSI Steelworks, Redcar: Priority areas within SSI Landholdings Contract 3, Geotechnical Risk Assessment Report, Prepared for South Tees Development Corporation by Arcadis, Ref Redcar Steelworks-AUK-XX-XX-RP-GE-0001-P1-SSI3_GI_GRA, dated November 2018 [Arcadis 2018 Appendix H10];

9 The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract 3, Ground Remediation Options Appraisal Report, Prepared for South Tees Development Corporation by Arcadis, Redcar Steelworks-AUK-XX-XX-RP-GE-0001-01-SSI3_GI_ROA, dated December 2018 [Arcadis 2018 Appendix H11];

10 The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract 3, Final Factual Report, Prepared for South Tees Development Corporation by Allied Exploration & Geotechnics Ltd (AEG), Ref 4155, dated June 2018 [AEG 2018 Appendix H12];

11 4251 - Prairie Site Ground Investigation Works (Final Report r01), Prepared for South Tees Development Corporation by Allied Exploration & Geotechnics Ltd (AEG), Ref 4251, dated November 2020 [AEG 2020 Appendix H13];

12 Eston Road Intrusive Works, Final Factual Report (Rev. 00), Prepared for South Tees Development Corporation by Allied Exploration & Geotechnics Ltd (AEG), Ref 4287, dated November 2020 [AEG 2020 Appendix H14];

13 Soil and Groundwater Baseline Characterisation Study, Teesside Works, prepared by Enviros for Corus UK Ltd [Enviros 2004 Appendix H15], Comprising:

   i Volume 1 – Factual Report, Ref. Rlp250604corusteessidefactual.Doc dated 25th June 2004 and marked Final;

   ii Volume 2 – Interpretive Report Ref. Mwicorusdraftinterpretivemmdv#2.Doc dated 25th June 2004 and marked Final; and,

   iii Volume 3 – Summary Report dated June 2004.

14 Phase 1 Environmental Review, Corus Cleveland Prairie Teesside Site, prepared by Enviros for Graphite Resources, Ref GR1280001, Draft Report, August 2007 [Enviros 2007 Appendix H16];

15 Phase 2 Geo-environmental Assessment, Corus Cleveland Prairie Teesside Site, prepared by Enviros for Graphite Resources, Ref GR1280001, Final Report, March 2008 [Enviros 2008 Appendix H17];

16 TS3 Grangetown Prairie – Phase 1 Geo-environmental Desk Study, prepared by CH2M Hill UK (CH2M) for Homes and Communities Agency, Ref. 678079_TS3_001, August 2017 [CH2M 2017 Appendix H18];

17 Former Corus Cleveland Prairie Site: Land off Clay Lane, Ground Investigation Report, prepared by MD2 for ONE North East, Ref. MD2_113, July 2011 [MD2 2011 Appendix H19];

18 Prairie Site: Land off Clay Lane, Ground Investigation Factual Report, prepared by Shadbolt Environmental LLP for ONE North East, July 2011 [Shadbolt 2011 Appendix H20];

19 Site 1 (Dorman Point) Redcar, North East England, TS10 1DZ, Enviro+Geo Insight Report, prepared by Groundsure for Arcadis, Ref: GS-7224470, 4th November 2020 [Groundsure 2020 Appendix H21];

20 Former Steelworks Land, South Tees Outline Remedial Strategy, Prepared for South Tees Development Corporation by Wood, Ref 41825-wood-XX-XX-RP-OC-0001_S0_P01 dated 25th June 2019 [Wood 2019].

H3.3 Potential and actual sources of contamination associated with the site are identified by considering the:

- Current and previous land use from a study of existing reports, current and historic maps, photographs, local history sources, environmental database information, and a site inspection; and
- Available intrusive site investigation data and contamination/ground conditions assessments.
- Following the identification of potential sources of contamination, the presence and sensitivity of receptors at risk from potential or known contamination are identified by consideration of the following.
- Surrounding land uses, based on mapping and site visits and existing planning designations;
- Proposed end-use, based on the nature of the proposed development;
- Type of construction operations that will be necessary during the construction phase of development;
- Nearby Sites of Nature Conservation Interest (SNCIs), Special Protection Areas (SPAs), Sites of Special Scientific interest (SSSI) and other protected areas; and
- Geology, hydrogeology and hydrology of the site and surrounding area.

H3.4 Where a significant source has been identified and potential sensitive receptors are present, the potential effects can be determined by considering the pathways through which the source/hazard may affect the receptors. The magnitude of effect and the significance of effect is then determined taking due account of the nature of the pathway between a source and a receptor.

H3.5 For each of the potential effects assessed to be likely, a qualitative assessment is made on the significance of the effect on the receptor.

Operational Phase – Scoped Out

H3.6 The operational phase of the proposed development has been scoped out from consideration in this chapter for the following reasons:

1 Contamination that is present at the site will be remediated and managed during the construction phase and therefore the risk from historic contamination during operation will be Negligible and Not Significant. This will primarily comprise remediation of Non Aqueous Phase Liquid (NAPL) impacted soils and the provision of a clean cover layer across the site to break direct contact and dust inhalation pathways;

2 It is assumed further assessment of ground gas risks will be undertaken in order to identify appropriate gas protection measures, if required, based on specific development proposals. The required gas protection measures would be incorporated into the buildings during construction and therefore the risk to the occupiers would be Negligible and Not Significant;

3 Whilst the proposed operational site is industrial (Class B2 and B8) and therefore may use, handle and/or store hazardous substances or wastes it is assumed that appropriate permits will be in place and such activities would be governed by legislation in order to operate

safely, therefore the risk from new contamination would be Negligible and Not Significant. Where required, storage tanks will be located within controlled areas and within bunding sufficient to contain liquids in case spillage or rupture;

4 It is also noted that post development the site will mainly be covered by buildings and hardstanding (access roads and car parks etc) which will also reduce the risk of contamination in spillage events from adversely affecting surface water or groundwater as well as reducing leaching of residual soil contamination due to rainfall;

5 It is assumed areas of hardstanding will be designed in accordance with best practice measures to avoid uncontrolled discharges to drains. Site drainage and networks will be lined with impermeable geomembrane so there is no interaction with contaminated land. Soakaways will be not be employed to limit mobilisation of contaminants. The groundwater beneath the site is considered low value (medium sensitivity);

6 It is assumed that the Holme Beck, Knitting Wife Beck and the cross connector will either remain culverted across the site or opened up to flow within lined channels so, in either eventuality, will not be in hydraulic continuity with groundwater or soil leachate;

7 It is assumed maintenance workers that are required to undertake ground excavations during the operational life of development will be provided with sufficient information on the nature of each sub-area, upon which to base site and task specific risk assessments;

8 Materials used in infrastructure will be designed and specified accordingly taking due account of the potential for aggressive ground conditions such as those related to the possible presence of elevated sulphate or the presence of ground gas; and

9 While the remediation strategy [Arcadis 2020 H4] does include for segregation and processing of potentially expansive slag deposits to reduce geotechnical risks, the preparation of a geotechnically suitable development platform for a specific redevelopment is the responsibility of the developer. It is assumed this will also apply to the TLRS Area.

H3.7 As discussed below, the Contaminated Land Officer at RCBC has been consulted and has agreed to the operational phase being scoped out of this chapter.

Significance Criteria

H3.8 The impact is assessed in terms of the sensitivity or importance of a receptor or feature, and the magnitude of change or scale of impact during the construction phase of the proposed development. The importance of potentially affected geological/geomorphological features and the sensitivity of receptors, which may be affected by land contamination impacts, have been assessed according to the four-point scale shown in Table H3.1 below.

Table H3.1 Significance criteria - sensitivity of receptors

Sensitivity / Value of Receptor	Receptors Susceptible to Land Contamination and Ground Hazard Impacts	Soil and Geological Resources
Very High	Residential areas or schools within 50 m of construction works Construction workers involved in below ground works Water features deemed to be of high value Ecological features deemed to be of high value Allotments, arable farmland, livestock or market gardens on or adjacent to the site	Internationally and nationally designated sites Regionally important sites with limited potential for substitution High quality agricultural soils (Grade 1 and 2) or soils of high nature conservation or landscape importance Presence of significant mineral reserves and within a Mineral Consultation Area

Sensitivity / Value of Receptor	Receptors Susceptible to Land Contamination and Ground Hazard Impacts	Soil and Geological Resources
		Soil/materials disposal required following earthworks resulting in a significant increase in demand on waste management infrastructure
High	Residential areas or schools within 50 to 250 m of construction works Commercial areas within 50 m of construction works Construction workers involved in above ground works Water features deemed to be of medium value Ecological features deemed to be of medium value The built environment including buildings and infrastructure	Regionally important sites with potential for substitution Locally designated sites with limited potential for substitution Good quality agricultural soils (Grade 3a) or soils of medium conservation or landscape importance Site within a Mineral Consultation Area Soils/materials disposal required following earthworks resulting in a moderate increase in demand on waste management infrastructure
Medium	Residential areas >250 m from construction works Commercial areas within 50 to 250 m of construction works Water features deemed to be of low value Ecological features deemed to be of low value	Undesignated sites of some local earth heritage interest Moderate or poor quality agricultural soils (Grade 3b or 4) or soils of low nature conservation or landscape importance Limited potential for mineral reserves and site not within a Mineral Consultation Area Soil/materials disposal required following earthworks resulting in a limited or minor increase in demand on waste management infrastructure
Low	Areas where there are no built structures, crops, or livestock Commercial areas within >250 m of construction works Ecological and water features deemed to be of negligible value	Other sites with little or no local earth heritage interest Very poor quality agricultural soils (Grade 5) or soils of negligible nature conservation or landscape importance. Negligible potential for mineral reserves to exist

H3.9 Table H3.2 below sets out the magnitude criteria used to assess the magnitude of impacts in this chapter.

Table H3.2 Significance Criteria - Magnitude of Impacts

Magnitude of Impact	Receptors Susceptible to Land Contamination and Ground Hazard Impacts	Soil and Geological Resources
High	Human Health: Acute risk to human health Surface waters and/or groundwater: Substantial acute pollution or long term degradation of sensitive water resources (Principal Aquifer, groundwater source protection zone, surface waters of good or very good quality) Ecology: Significant change to the number of one or more species or ecosystems Built Environment: Catastrophic damage to buildings, structures or the environment Landscaping/Agriculture: Loss in value of livestock or crops as a result of death, disease, or physical damage.	Loss of feature or attribute Earthworks resulting in high volume of surplus soil for off-site disposal Classification of surplus soil as Hazardous Waste where the intention is to discard
Medium	Human Health: Chronic risk to human health Surface water and/or groundwater: Pollution of non-sensitive water resources or small scale pollution of sensitive water resources (Principal or Secondary Aquifers of water courses of fair quality or below) Ecology: Change to population densities of non-sensitive species Built Environment: Damage to buildings, structures or the environment Landscaping/Agriculture: Non-permanent health effects to vegetation/crops from disease or physical damage, which results in a reduction in value.	Impact on integrity of or partial loss of feature or attribute Earthworks resulting in moderate volume of surplus soil for off-site disposal
Low	Human Health: Slight reversible short-term effects to human health Surface waters and/or groundwater: Slight pollution of non-sensitive water resources Ecology: Some change to population densities of non- sensitive species with no negative effects on the function of the ecosystem Built Environment: Easily reparable effects of damage to buildings or structures Landscaping/Agriculture: Slight or short term health effects which result in slight reduction in value	Minor impact on feature or attribute Earthworks resulting in low volume of surplus soil for off-site disposal
Negligible	Human Health: No measurable effects on humans Surface waters and/or groundwater: Insubstantial pollution to non-sensitive water resource Ecology: No significant changes to population densities in the environment or in any ecosystem Built Environment: Very slight non structural damage or cosmetic harm to buildings or structures Landscaping/Agriculture: No significant reduction in landscape value.	Impact of insufficient magnitude to affect use or integrity of feature or attribute No off-site disposal of surplus soil required

H3.10 The significance of the effect of the impact (adverse or beneficial) has been determined in accordance with the matrix shown in Table H3.3 below.

Table H3.3 Significance Criteria - Significance of Effect

	Magnitude of Impact			
Sensitivity/value of a Receptor	**High**	**Medium**	**Low**	**Negligible**
Very High	Substantial	Substantial	Moderate	Minor
High	Substantial	Moderate	Minor	Negligible
Medium	Moderate	Minor	Negligible	Negligible
Low	Minor	Negligible	Negligible	Negligible

H3.11 The above significance of effects criteria are all considered to be Adverse. It is considered that any potential impact determined with a significance of Moderate Adverse or Substantial Adverse is a significant impact for the purposes of this EIA.

Consultation

H3.12 Arcadis (UK) Ltd undertook consultation regarding this chapter with Mick Gent, Contaminated Land Officer, RCBC on 9th November 2020 concerning the basis for the assessment including the available sources of information, the remediation strategy [Arcadis 2020 H4], scoping out the operational phase of the assessment and the suitability of the Significance Criteria described above.

H3.13 RCBC have confirmed that the Significance Criteria proposed for this assessment are acceptable (See Appendix H2).

Assumptions and Limitations

H3.14 The conclusions reached within this ES chapter are based in part upon information and/or documents that have been prepared by third parties. In view of this, we accept no responsibility or liability of any kind in relation to such third party information and no representation, warranty or undertaking of any kind, express or implied, is made with respect to the completeness, accuracy or adequacy of such third party information.

H3.15 There have been a number of previous intrusive investigations undertaken across the proposed development site involving significant scopes of geochemical and geotechnical assessment such that ground conditions and contamination at the site are considered to be well characterised. However, while a remediation strategy has been developed [Arcadis 2020 H4] there remain some outstanding data gaps and aspects of remediation design which require addressing prior to remediation and redevelopment.

H3.16 Development will be phased over 11 years and that the engineering design for each phase of development will need to determine the detailed remediation approach based on the intended layout and form of development, to render the site suitable for use. The remediation design statement for each phase will set out how the proposed development conforms with the remediation strategy which may need to be informed by additional ground investigation and/or risk assessment required. The assessment undertaken within this chapter is supported by the Detailed Conceptual Site Model and Risk Assessment [Arcadis 2020 H1] and the Remediation Options Appraisal and Enabling Earthworks and Remediation Strategy Report [Arcadis 2020 H4] which identifies the relevant SPR linkages (based on current data) and the overarching remediation strategy required to address potential risks to identified receptors. These reports considered the proposed development site with the exception of the former Torpedo Ladle Workshop area, however the data reviewed suggests they are broadly applicable to this area.

H3.17 The Detailed Conceptual Site Model and Risk Assessment [Arcadis 2020 Appendix H1] concluded that the groundwater beneath the site is of low resource potential. Therefore, the Remediation Strategy [Arcadis 2020 H4] does not include active groundwater remediation. This consideration and approach is also in accordance with the accepted Outline Remediation Strategy for the South Industrial Zone [Wood 2019] located immediately north of the proposed development site. Therefore, it is assumed that Remediation Strategy [Arcadis 2020 H4] is acceptable and that active remediation of groundwater is not required (subject to any further data that may be obtained as part of addressing identified data gaps). However, the proposed works will remove NAPL and result in betterment of underlying groundwater quality. The effect of the proposed development on groundwater is however still considered in this EIA (see Sections G5 and G7 below).

H3.18 The Remediation Strategy [Arcadis 2020 Appendix H4] developed in relation to the Dorman Point area, excluding the former TLRS Area, is assumed to be appropriate and acceptable for the TLRS Area.

H3.19 This chapter and the EIA assume that the site will be cut and fill neutral and that excavated material can be reused onsite to construct the development platform. The maximum development height is anticipated to be 46.8m and this allows for a greater Finished Floor Level (FFL) dependant on developer requirements. The minimum FFL is 8.00m AOD.

H3.20 The TLRS that is currently located on site is currently the subject of an application for its demolition under a separate consenting process) which include a Demolition Method Statement. For the purpose of this EIA, the demolition of all other on-site infrastructure will be subject to separate consents. Other buildings on site have already been the subject of Prior Approval applications. Demolition has not, therefore, been accounted for in this chapter.

H3.21 A redundant railway embankment of approximately 15m in height running in a north-south direction is present in the south western part of the site and it is understood this is to be removed as part of the works secured through a separate planning application (Ref. R2020/0318/FFM).

H3.22 An Energy from Waste scheme has recently been approved in the north western part of the site (reference. R/2019/0767/OOM). The proposed development subject of this application could be brought forward to complement this scheme. It is considered likely that the bunker shown on proposed layout plans for the Energy from Waste scheme is likely to be below ground and thus it is assumed that any excavated volume will be addressed by the developer.

H4.0 Baseline Conditions

Existing Conditions

H4.1 The Dorman Point proposed development site is located off Eston Road, Middlesbrough, Cleveland, TS6 6TY. The site is 57.8 hectares and centred at Ordnance Survey (OS) National Grid eastings of 454739 and northing 521425. It is located in the south western part of the Teesworks area and lies between the 'Lackenby' area and the South Tees Freight Park.

H4.2 The site is approximately rectangular in shape and is defined by the existing surrounding infrastructure. The site has previously been used in iron and steel making and was previously extensively occupied by buildings associated with the Cleveland Iron and Steel Works. Most of the site is now free from built structures with the exception of a small relic Oxygen Plant, a former Loco Repair Shop and the former Torpedo Ladle Repair Shop (TLRS) which is located in the southern part of the site. Aside from the former workshop building, most of the ground cover is a mixture of hardstanding and patchy scrub and grasses, and there are some relatively small pools of standing water in the central northern part of the site.

H4.3 A Site Layout and Areas Plan is presented as Appendix H3;

H4.4 The topography of the site is relatively flat although there is very gentle slope downwards from south to north, with typical ground levels ranging from approximately 10.5m Above Ordnance Datum ('AOD') to 8m AOD. Some mounds were present in the area of the former blast furnaces. The coke oven area is raised up. The east of the site is significantly above Tees Dock Road and marked as artificial ground by the British Geological Survey.

H4.5 A redundant railway embankment of approximately 15m in height running in a north-south direction is present in the south western part of the site and it is understood this is to be removed as part of the works secured through a separate planning application (Ref. R2020/0318/FFM). In addition, a depression containing current and redundant utilities running north south adjacent to the main western boundary where the topography dips down to an underpass beneath the railway;

H4.6 The site is bordered to the north by the Redcar to Middlesbrough railway with the South Industrial Zone (historically largely reclaimed from the Tees Estuary) beyond which includes a range of current and former landfill and waste management facilities and potentially contaminative land uses associated with historic iron and steel industrial activities (described in Section H4.17). The site is bordered to the east by the A1053 Tees Dock Road, with the Basic Oxygen Steel (BOS) plant and rolling mills of Lackenby Works on the other side of Tees Dock Road. To the west the site is bordered by Eston Road and an Industrial Estate beyond including primarily freight, hire storage facilities. An electrical substation and the Bolckow Industrial Estate are located adjacent to the southern site boundary.

H4.7 The site is broadly divided by roadways in to four areas: the north and east quadrants are largely derelict, the west quadrant contains the embankment, Loco Repair shop and oxygen tanks and the southern quadrant contains the TLRS with a number of small outbuildings.

H4.8 Arcadis has not been provided and has not reviewed any correspondence or reports related to previous demolition and reclamation works undertaken at the site but it is assumed that all relevant legislative requirements regarding the demolition works and possible presence of asbestos were adhered to.

On Site Infrastructure

H4.9 An internal private road network exists across the whole of the Teesworks area. Those within this site include a road running in a north-east south-west direction across the site which previously connected to Tees Dock Road in the north east corner and to the roads around the Bolckow Industrial Estate in the south west corner via the former Bessemer Gate.

H4.10 The former Hot Metal Transfer Railway extends into the southern part of the site, with sidings both to the north and south of the former Torpedo Ladle Repair Shop building.

H4.11 National grid electricity infrastructure is present across the site. This includes five electricity pylons and associated overhead electricity lines running along the north western and eastern edges of the site. An electricity sub station is present in the north eastern corner of the site and a power transmission line is also present under the south eastern part of the site.

H4.12 The Holme Beck runs in a north west-south east direction along the western edge of the site, with the southern end being open, and the remainder culverted underground. The Knitting Wife Beck runs in a north-south direction across the eastern side of the site via an underground culvert. A cross connector, which is believed to link the two becks, also via an underground culvert, is present under the site at its southern extent.

H4.13 The Teesworks area contains a large network of critical industrial utility infrastructure. The now redundant Coke Oven Gas Main ("COGM"), is present above ground on the southern and western parts of the site which contains hazardous material and is controlled under a nitrogen blanket to prevent ignition. At the time of writing this is in the process of being removed. This is considered a top tier COMAH asset. In addition, a section of Natural Gas Pipeline is noted to be present adjacent to the TLRS.

H4.14 Water infrastructure present on the site comprises: potable water supply pipes cross the central part of the site in a north-east south-west direct and cross the southern part of the site in a north-west south-east direction; industrial water mains are present under the southern and western parts of the site; and a municipal sewer transfer mains crosses under the northern part of the site in an east west direction.

H4.15 In addition, a network of BT Openreach Underground lines is shown to be present (CH2M 2017 H18] within the North Quadrant and the TLRS area as well as a BOC Oxygen Pipeline within the North Quadrant. Other services (BOC Nitrogen and Hydrogen Pipelines, Fuel Oil Pipelines, Northern Gas Network Low and Medium Pressure lines) are stated to be present within the CH2M Phase 1 Geo-environmental Desk Study report but not shown to be located on site within the associated report Figure therefore their presence should be confirmed.

H4.16 A range of relic and redundant services are likely to be present across the site associated with historic site activities which is illustrated by the identification of redundant electric cables, clay field drains, cast iron and plastic pipes identified during intrusive site works undertaken by AEG Ltd in 2018 and 2020 [AEG 2018 H12 and 2020 H14].

Historical Setting

H4.17 A review of the historical development of the site was undertaken as part of the Phase 1 Geo-Environmental Desk Study [CH2M 2017 H18], which referred to the site as TS3 and included information from Sahaviriya Steel Industries (SSI) site records, as well as part of the Phase 1 Environmental Review by Enviros [Enviros 2006 H16]. In addition, an up to date Groundsure Report [Groundsure 2020 H21] was obtained for the purposes of this ES. These reports have been reviewed and summarised below.

Table H4.1 Summary of Historic Site Development and Activities

Date	Description	
	Within Site Boundary	**Outside Site Boundary**
1857	Cleveland Steel Works is located in the northwest corner of the site with railway lines leading in from the south. The adjacent Cleveland Iron Works encroaches into the northwest corner of the site, west of the Steel Works and are served by the same group of tracks. A reservoir associated with the Iron Works is located within the far northwest corner of the site, Station Road crosses the site diagonally from southwest to northeast. Knitting Wife Beck is shown running through the eastern side of the site off Station Road.	A Gas Works approximately 40m to the west of site. Allotment gardens are shown in the south of the site, off Bessemer Street. Ponds are shown off Station Road, in east of the site. Residential properties are shown to the south of the site, with Eston Grange Station on the Middlesbrough to Redcar Railway Line adjacent to the northeast of the site. Holme Beck Bridge is shown adjacent to the northwest corner of the site. South Bank Iron Works are recorded adjacent to the northeast of the site, with Lackenby Iron Works ~600m northeast of site.
1915	The reservoir in the far northwest corner of the site is no longer shown, with new building occupying its footprint. Athletic Ground and Cricket & Football Pitch have been built in the vicinity of the current TLRS, whilst Cleveland Steel Works has expanded eastwards, with additional railway lines servicing the works from the east and southwest, and sidings to the northeast.	Additional railway lines have been built to the northwest of the site towards the River Tees. Eston Grange Station has also been renamed Grangetown Station.
1929	A building similar to the TLRS is shown in current position on site, with associated railway lines and sidings. At this time the building is believed to have been operating as the South Steel Plant. An Engineering Works is shown off Station Road in northeast corner of site, with Cooling ponds and Pumping Station located off Station Road in the southeast corner of site. New large structures are shown north of TLRS in the central area of site. Numerous tanks are shown in the northwest of the site, with numerous travelling cranes shown adjacent to the railway lines across the site.	A Tarmacadam Works is shown adjacent to Grangetown Station.

Date	Description	
	Within Site Boundary	**Outside Site Boundary**
1953	Several chimneys are shown adjacent to buildings within the northwest corner of the site, as well as several travelling cranes. A Blast Furnace and numerous associated tanks are shown within the western area of site, east of the railway tracks. Adjacent to the south are the Cleveland Coke Ovens; with a Gas Holder located to the east. A Coal conveyor runs between the Coke Cooling Tower of the coke ovens to Cleveland Iron Works. Several travelling Cranes are noted around the coke ovens, as well as numerous pipelines. At the southern end of the coke ovens, within the far southwest corner a Cooling Plant with numerous tanks is recorded. A series of chimneys and pipes are noted along the northern boundary, associated with the larger of the steel works buildings. Several chimneys, tanks and pipelines are shown along the southern side of TLRS. Tees Dock Road has been constructed and Knitting Wife Beck has been culverted. Electrical substations are shown in the central to eastern area of the site.	The Docks to the northwest of the site are more developed.
1962	The Blast Furnace within the western area of the site is no longer denoted, and whilst the main building and track remain, the associated tanks have been removed. Similarly, the Cleveland Coke Ovens and adjacent Cooling Plant and Gas Holder are no longer denoted, however the buildings and structures largely remain. The coal conveyor and Coke Oven Cooling Tower have been demolished, suggesting that the Coke Ovens are derelict. The adjacent Cleveland Iron Works are undergoing redevelopment, with the associated tanks located in the far northwest of site no longer shown.	No significant changes
1971	New conveyor belts are shown across railways in the east and northeast corner of the site linking to the adjacent works. A new electric substation shown in northwest corner of the site, with chimneys shown in the central to western part of the site, the northwest corner and at northern end of the large central structure. A tank is shown at southernmost end of the large central structure. A large substation in noted in the northern central part of the site, adjacent to the railway. The chimneys, tanks and pipes located along the southern side of the TLRS are no longer shown and the site of the former Blast Furnace has	The reservoirs and Pumping Station in the west of the site, off Station Road are no longer shown.

Date	Description	
	Within Site Boundary	**Outside Site Boundary**
	been redeveloped as has the adjacent Cleveland Iron Works site.	
1983	TLRS and the Ingot Bogie & Wagon Repair Shop are shown in their current arrangement. A number of buildings are noted in the present-day empty area north and northeast of the TLRS. Additional buildings on site include: Bessemer Furnace, Mills Services Department; Autofab Plant; Spares Buildings; Main Electric Repair Shop; Colliery Arch Plant, Arc Melting Plant, Loco Repair Shop and multiple substations and transformers. Nos. 3, 6 and 7 Mills (on site) have been decommissioned and demolished shortly after.	No significant changes
1987	The former Cleveland Coke Ovens have been demolished, along with some of the railway tracks and sidings which previously served the ovens and ran along the western boundary of the site. Many of the buildings which formed the Cleveland Steel Works have been demolished. The major buildings in the central area of the site are no longer shown. New large circular tanks are also shown in the northwest corner of site. The large rectangular structure in the southwest corner is also no longer shown. A Flare stack and associated pipeline is shown in the west of the site.	The A66 is shown to the southwest of the site. New, large circular tanks are also recorded adjacent to Tees Dock Road, west of the site. Land to the south west of site is less industrialised with offices and residential areas.
1992	The centre of the site is derelict, however the large structure on the eastern side still present.	Industrial development has occurred to the east and north of site, with commercial and residential development to the west and south
2000	Structures no longer shown along the western side of site with the exception of a pump house. The large structure on eastern side of the site is still present. The Gas holder in northwest corner of site is no longer shown.	Industrial development has continued to the east and north of site, with commercial and residential development to the west and south
2007	No significant changes	No significant changes
2010	The site is mostly derelict except for the TLRS, embankment adjacent to the pump house and the main pipe bridge.	Clay Lane Commercial Park is shown to the west of the site. Industrial and residential housing has been built in Grangetown to the south of TS3, with Cleveland Teesside Works to the north, north of the railway lines.

H4.18 Previous Environmental Assessments

H4.19 Available and relevant historic reports and exploratory location records have been identified by Arcadis and these are used to inform the baseline assessment to this EIA.

H4.20 The scope and relevance of previous intrusive environmental site investigations is given in Table H4.2 below

Table H4.2 Summary of Previous Site Investigations

Relevant & Available Reports	Relevant Site Area	Outline Scope
Enviros Ltd 2004 [H15]	Torpedo Ladle Repair Shop (TLRS) Area Only	Advancement of 2 trial pits using a 20 tonne tracked excavator and 1 borehole using a shell and auger rig. Collection of 6 soil samples and 1 groundwater sample analysed for pH, metals, sulphide, petroleum hydrocarbons, phenols, cyanide. No surface water or asbestos testing included.
Enviros Ltd 2008 [H16]	Western part of North and West Quadrants around former Cleveland Coke Ovens and Cleveland Steelworks.	Desk study with advancement of 10 trial pits to a maximum depth of 2.8m bgl adjacent to the former Cleveland Coke Ovens No testing data, later presented in Enviros Ltd 2008 [H17]
Enviros Ltd 2008 [H17]	Western part of North and West Quadrants around former Cleveland Coke Ovens and Cleveland Steelworks.	Advancement of 41 trial pits to a maximum depth of 4m bgl, 10 window sample holes up to 4m bgl and 8 boreholes (shell and auger) to a maximum depth of 10m bgl. Surface water sampling from Holme Beck. Completion of six rounds of gas monitoring and three rounds of groundwater monitoring. Sampling and analysis of 51 soil samples for pH, sulphates, sulphide, metals, Loss on Ignition (LOI) and Calorific Value (CV), cyanides, asbestos (screen), petroleum hydrocarbons, volatile and semi-volatile organic compounds (VOCs and SVOCs), PAHs, PCBs and phenols. Analysis of 11 soil leachates for the same suite as soil samples (except LOI, CV, TOC and asbestos). Sampling and analysis of groundwater and surface water samples for hardness, pH, metals, sulphate, sulphide, cyanides, petroleum hydrocarbons, PAHs, PCBs, phenols, VOCs and SVOCs.
Shadbolt Environmental LLP 2011 [H20] – Factual Report MD2 2011 [H19] – Interpretive Report	Proposed development site excluding TRLS but including addition land to northwest of site adjacent to railway.	13 No. cable percussive boreholes were advanced to between 1.7m bgl and 10.2m bgl. 14 No. window samples were drilled with 8 abandoned due to obstructions/hard strata. 16 No. trial pits were excavated to between 0.5m bgl and 4.2m bgl. In situ geotechnical testing was undertaken in cable percussive boreholes – Standard Penetrometer Testing (SPT) and hand shear vane tests. 35 No. soil samples were analysed for pH, sulphates, sulphur, metals, cyanides, petroleum hydrocarbons, phenols and PAHs. 3 No. water samples were analysed for pH, sulphates, sulphur, metals, cyanides, petroleum hydrocarbons, ammonia and PAHs. 4 No. soil samples were scheduled for Emery slag expansion testing and 3 No. samples scheduled for California Bearing Ratio (CBR) testing.

Relevant & Available Reports	Relevant Site Area	Outline Scope
Allied Exploration & Geotechnics Ltd 2018 [H12] Arcadis UK Ltd (2018) [H7]	TLRS Area	42 No. trial pits and to a maximum depth of 4.2m bgl. 2 No. cable percussive boreholes to a maximum depth of 7.3m bgl. Analysis of 6 bulk slag samples for sulphates, thermal analysis, accelerated expansion tests. Analysis of 293 soil and 30 leachate samples for metals, pH , cyanides, sulphur species, organic matter, petroleum hydrocarbons, PCBs, phenols, VOC, SVOCs. asbestos and PAHs. Laboratory geotechnical testing on soil samples including moisture content, plasticity index, particle size distribution, dry density-moisture content relationships, 1D consolidation, shear strength, point load, unconfined compressive strength, XRF and slag analysis. In-situ testing via SPT, hand shear vane tests and Photo Ionisation Detection (PID). UXO survey – no anomalies identified. Groundwater sampling from 2 locations on 6 occasions (Nov 2017 to May 2018) and analysis for metals, pH, cyanides, phenols, sulphates, petroleum hydrocarbons and PAHs. Soil gas monitoring analysis from 2 locations on 5 occasions (Nov 2017 to May 2018).
Allied Exploration & Geotechnics Ltd 2020 (Rev.00 and Rev.01) [H13 and H14] – Draft Factual Reports Arcadis UK Ltd (2020) [H5 and H6] – Interpretive Report plus Addendum	Majority of Dorman Point development site excluding TLRS area	110 No. trial pits excavated by a 20 tonne 360 excavator, to a target depth of 4.5m or refusal, or until natural material was encountered. 10 No. cable-percussive boreholes, to between 10m and 20m, or refusal on bedrock, 4 No. of these advanced 5m into underlying bedrock. Soil sampling for in-field assessment (SPT, hand shear vane, PID) and chemical analysis for asbestos, metals, VOCs, SVOCs, LOI, CV, pH, cyanides, organic matter, sulphur species, petroleum hydrocarbons, PAHs, PCBs and phenols. Leachate analysis for metals, pH, cyanide, ammonia, chloride, sulphate, petroleum, hydrocarbons, PAHs and phenols. Slag testing including petrology and expansion tests. Geotechnical laboratory testing of soil samples for including moisture content, plasticity index, particle density, particle size distribution, shear strength, point load, unconfined compressive strength. Installation of 12no. groundwater monitoring wells (including 2no. twin installations) with subsequent groundwater elevation survey, tidal monitoring, hydraulic conductivity slug tests and monitoring. Groundwater samples analysed for metals, pH, cyanides, DOC, chloride, nitrate, nitrite, ammoniacal nitrogen, salinity, sulphate, sulphur, petroleum hydrocarbons, PAHs and phenols.

Data Gaps

H4.21 There have been a number of previous intrusive investigations undertaken across the proposed development site involving significant scopes of geochemical and geotechnical assessment such that ground conditions and contamination at the site are considered to be well characterised. However, while a remediation strategy has been developed [Arcadis 2020 H4] there remain some outstanding aspects of remediation design which require confirmation prior to remediation and redevelopment. These are as follows:

1 Potential geotechnical constraints have been identified at the site (including a limited quantity of potentially expansive slag deposits, settlement, subsurface obstructions and sulphate attack of concrete) with potential measures to manage these constraints outlined within the remediation strategy [Arcadis 2020 Appendix H4]. However, it was not within the scope of the current remediation strategy to fully address geotechnical development constraints as these are dependent on a specific redevelopment scenario.

2 Previous site assessments have not identified an unacceptable risk to human health or built receptors from the accumulation of ground gas. However, as ground investigations were not designed with a particular redevelopment scenario in mind, the gas monitoring data was limited and may not be representative of the entire extent of the site under a particular redevelopment. Additional ground gas monitoring at greater density is recommended prior to any specific redevelopment to determine the risk from ground gases on the site, the scope of this investigation would depend on the proposed redevelopment scenario.

H4.22 Other Assumptions and Limitations are detailed in Section H3.14 to H3.22.

Geology

H4.23 The British Geological Society (BGS) solid and drift geological map (Sheet 33 -1987) 1:50,000, the BGS GeoIndex Onshore (online resource) and historical exploratory location records have been reviewed in order to assess the geological composition of the site which is summarised in this section.

H4.24 Made Ground covered the entire site footprint ranged in depth between 0.6 and >5.0 m bgl (below ground level) with the majority of the site covered by between 1 and 3m of Made Ground. Areas of deeper Made Ground were noted, particularly in the area of the Former Clevel and Coke Ovens and No. 3 Primary Mill and in the east towards Tees Dock Road. Obstructions including slabs and foundations prevented the base of the Made Ground being proven in approximately 50% of locations. Large areas of concrete surfacing are present particularly in the east of the site, a second large concrete slab was identified in the area of the former coke ovens, this was noted to be underlain by a large void approximately 2-3m deep.

H4.25 Three types of Made Ground were noted:

1 Slag-dominant material (>50% slag): Identified in 20% of locations and generally ranging from gravel to cobble and occasional boulder size fragments. The slag was generally vesicular and grey-green in colour with some white crystallisation/discolouration often noted on the outer surface along with occasional iron rich areas.

2 Granular Made Ground: Identified widely across the site of varying composition, most frequently a sandy gravel with varying cobble content, although occasionally also clayey. Gravel and cobbles include brick (including refractory), concrete and other demolition materials, slag was not the dominant constituent although often still present within the soil matrix.

3 Cohesive Made Ground: Frequently identified below the granular Made Ground

H4.26 The BGS maps indicate the Made Ground is underlain by Glaciolacustrine Deposits predominantly comprising laminated clays and silt. These deposits are likely to be underlain by Glacial Till predominantly comprising slightly gravelly clay. Tidal Flat deposits were identified by ground investigations but were shown to be thin and discontinuous.

H4.27 Bedrock beneath the southern 10% of the site is anticipated to comprise Redcar Mudstone Formation, part of the Lias Group. The northern 80% of the site is anticipated to be underlain by the Mercia Mudstone Group. The Penarth Group is indicated to be present between the two units running northeast to south west through the site. The geological sequence of units comprises:

1 Redcar Mudstone Formation (up to 250m thick but only basal part of unit likely to be present beneath the site) comprising grey fossiliferous, fissile mudstones and siltstones with subordinate thin beds of shelly limestone in lower part and argillaceous limestone concretions throughout;

2 Penarth Group (approximately 15m in thickness) comprising grey to black mudstones with subordinate limestones and sandstones;

3 Mercia Mudstone Group (approximately 200m in thickness) comprising predominantly red mudstones and subordinate siltstones with thick halite-bearing units.

4 Sherwood Sandstone underlies approximately 200m thickness of Mercia Mudstone.

H4.28 The desk study CH2M (2017) suggests that bedrock is dipping approximately 14 degrees to the north northwest.

H4.29 The Made Ground will present a constraint to future redevelopment in its current state as is expected to vary from low bearing capacity and high compressibility in places to dense slag requiring breaking out and crushing. Old foundations and in-ground structures will present obstructions for new foundation construction and potential hard spots inducing differential settlement [Arcadis 2018 H10, MD2 2011 H19].

H4.30 The depth of Made Ground was not fully proven in all locations across the site, mainly due to large obstructions associated with old foundations, in particular near the former blast furnaces and coke works. Reinforced concrete floor slabs associated with historic buildings with localised buried concrete obstructions were also detected at a number of locations, in areas beneath former building footprints [AEG 2018 H1, 2020 H13 H14, Enviros 2008 H16].

H4.31 Certain types of slag may pose a risk to future buildings and structures due to their potential to exhibit volumetric instability. It can also weather resulting in creating tufa (calcium hydroxide and calcium carbonate precipitates), which can be mobilised in surface and groundwater leading to damage to drainage infrastructure and unsightly deposits in watercourses. Slags are also characterised by elevated sulphate content [CH2M 2017 H18] which may attack subsurface concrete.

H4.32 By the nature of their deposition the underlying superficial Tidal Flat Deposits are highly susceptible to compression resulting in excessive settlement, whilst their high organic content would also likely lead to long term secondary compression. This will need to be considered within the design of any future developments on site [CH2M 2017 H18].

H4.33 Potential geotechnical development constraints were also identified within the Remediation Options Appraisal, Enabling Earthworks and Remediation Strategy Report [Arcadis 2020 H4, 2018 H10] which may present significant development constraints at the site:

1 Expansive slag deposits and refractory bricks may lead to disruption and damage of structures, hardstanding etc.;

2 Due to long term creep settlement, the Made Ground and underlying Tidal Flat Deposits may possess inadequate bearing capacity to support proposed structures;

3 Lateral and vertical changes in ground conditions;

4 Anticipated total and differential settlement / heave in excess of the tolerable limits may occur due to changes in loading or groundwater regime;

5 Potential collapse or inundation settlement as a result of surface water infiltration and groundwater movement;

6 Sulphate attack on subsurface concrete; and,

7 Obstructions within the made ground (boulder size fragments of slag and buried underground structures).

8 If new foundations penetrating the Glacial Till (below 5m bgl) are proposed, a foundation works risk assessment should be carried out to enable appropriate mitigation measures to be designed that will prevent contaminant migration via a preferential pathway down into the underlying bedrock aquifers.

9 Within the TLRS Area the following geotechnical constraints were identified [Arcais 2020 H10];

10 Inadequate bearing capacity of made ground to support proposed structures;

11 Variations in depth/thickness of made ground due to former structures (e.g. former lagoons, basements within existing structures).

12 Anticipated total and differential settlement/heave in excess of the tolerable limits;

13 Potential collapse compression as a result of surface water infiltration and groundwater movement;

14 Potential heave as a result of chemical changes causing expansion of the ferrous slag;

15 Sulphate attack of concrete (from made ground and Mercia Mudstone); and

16 Obstructions within the made ground (boulder size fragments of slag and buried underground structures) and natural ground (boulders in glacial till).

H4.34 The site is identified by the Groundsure Report (Groundsure 2020 H21] as being at low or very low risk from shrink swell, running sand, collapsible deposits and landslide hazards. It is identified as being at moderate risk from compressible ground hazards. The southern area of the site is identified as being underlain by evaporate mining.

H4.35 With reference to the Coal Authority Interactive Map the site is not within a Coal Mining Reporting Area. This is consistent with BGS mapping and the Groundsure Report (Groundsure 2020 H21] as such coal mining is not discussed further within this report.

Hydrology and Hydrogeology

Hydrology

H4.36 The River Tees is approximately 1.3km to the northwest of the site and is classified by the Environment Agency as a Main River.

H4.37 Holme Beck is shown approximately 110m south from the southwest corner of the site, parallel with Eston Road and north of the A66 and it then runs along the inside western edge of the site. The watercourse is understood to be culverted as it passes through the site as both an open and covered feature to discharge at the Cleveland Channel which flows to the River Tees via the Lackenby Channel.

H4.38 Knitting Wife Beck is shown immediately southwest of the site, running from the A66 close to the TLRS railway line. It is culverted along the eastern side of the site discharging to the South Lackenby Effluent Management System (SLEMS). Works to daylight (open culvert) Holme Beck as part of the site redevelopment are to be confirmed.

H4.39 Both the Holme Beck and the Knitting Wife Beck flow south to north, and ultimately discharge into the River Tees via the Cleveland and Lackenby Channels and the SLEMS.

Hydrogeology

H4.40 The BGS Superficial Deposits Aquifer Maps show that the superficial deposits at the site (Glaciolacustrine Deposits – clay and silt) are classified as Unproductive Strata indicating this unit has low permeability with negligible significance for water supply or base river flow. The Tidal Flat Deposits are classified as a Secondary A Aquifer.

H4.41 The BGS Bedrock Aquifer Maps show that the Redcar Mudstone Formation and mudstone of the Penarth Group are Secondary (undifferentiated) Aquifers and the Mercia Mudstone Group in the remainder of the site is a Secondary B Aquifer.

H4.42 The EA describe a Secondary B Aquifer as "predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering". A Secondary Undifferentiated is defined as "assigned in cases where it has not been possible to attribute either category A or B". This generally means that the horizon has variable characteristics allowing it to function as both a minor and non-aquifer in different locations.

H4.43 The Sherwood Sandstone is a Principal Aquifer and as such is important for water supply and/or base river flow on a strategic scale. At the site, the Sherwood Sandstone is understood to be at depth and overlain by a significant thickness of Mercia Mudstone (approximately 200m). As such, this aquifer is likely to have limited connectivity with groundwater encountered in the superficial and bedrock deposits identified as part of the site investigation.

H4.44 The site is not located within a Groundwater Source Protection Zone, nor within a surface water, groundwater or eutrophic Nitrate Vulnerable Area. The superficial and bedrock aquifers at the site have a Groundwater Vulnerability Classification of "Low Vulnerability".

H4.45 Recent site investigation work by Arcadis (Arcadis 2020 H5 and H6] found that ground water flow direction within superficial deposits was largely dictated by localised preferential pathways while flow within the bedrock geology was primarily north to northeast.

H4.46 Arcadis (Arcadis 2020 H5 and H6] also identified groundwater within the Made Ground in approximately 50% of locations at depths between 0.3 and 3.5 m bgl with inflow rates ranging between low to heavy. The groundwater was considered to be locally confined within sub surface structures and more permeable granular Made Ground and not considered to represent a consistent groundwater body across the site.

Land Contamination

Potential Sources of On-Site Contamination

H4.47 Notable historic and contemporary features within the area which may have implications for land contamination include but are not limited to:

1 Iron and Steel Making Facilities notably the Former Cleveland Iron and Steel Works (North Quadrant);

2 Cleveland Coke Ovens and Biproducts Plant (West Quadrant);

3 Torpedo Ladle Repair Shop (TLRS Area);

4 Power Station, Electrical Substations and Transformers(multiple site wide);

5 Railways and Sidings (multiple site wide notably in West Quadrant);

6 Made Ground including slag deposits (site wide);

7 Above Ground Storage Tanks (multiple site wide);

8 Workshops, Laboratories and Maintenance Facilities (multiple site wide e.g. Loco Repair Shop and former paint shop, mill scale buildings, water treatment plants, pump house, colliery arch plant);

9 Infilled Reservoir (North Quadrant);

Potential Source of Off-Site Contamination

H4.48 Notable historic and contemporary features outside of the site boundary which may have implications for land contamination include but are not limited to

1 Former SSI High Tip - Iron and steel by-products landfill (North) – potentially overlying an older ICI facility;

2 Highfield Environmental Facilities – Hazardous and non-hazardous waste landfill (North East) – potentially overlying an older ICI facility;

3 South Bank Coke Ovens and Biproducts Plant (SBCO) (North East);

4 Parts of the former Cleveland Biproducts Plant (South East).

5 Former Gas Works and Gas Holder (East / North East).

6 South Bank Iron Works (North East);

7 South Teesside Iron and Steel Works Lackenby – BOS Concast Plant (East);

Non-Aqueous Phase Liquid

H4.49 A non-aqueous phase liquid (NAPL) was identified in the following locations across site (excluding the TLRS area) during previous intrusive investigations.

Table H4.3 Summary of NAPL Encountered During Previous Site Investigations

Location	Geology	Description
Prairie_AUK_TP114 (0.9m bgl)	Made Ground	Tar noted within and surrounding a clay pipe
Prairie_AUK_TP142 (1.5m bgl)	Made Ground	Globules of oil noted in perched water. Water perched on fine silt overlaying concrete slab.
Prairie_AUK_TP175 (0.6mbgl)	Made Ground	Tar noted within and surrounding a clay pipe
Prairie_AUK_TP179 (1.4mbgl)	Made Ground	NAPL noted at the base of the made ground potentially associated with a relic slab / railway structure adjacent to the coke oven slab (Plate 3).
Prairie_AUK_TP182 (0.9mbgl)	Made Ground	NAPL noted at the base of the made ground potentially associated with a relic slab / railway structure adjacent to the coke oven slab.
Prairie_AUK_TP194A (1.4mbgl)	Made Ground	NAPL noted at the base of the made ground

Location	Geology	Description
Enviros CCOT4 (1.5-1.5mbgl)	Made Ground	Associated with made ground at the coke ovens. Potentially perched on natural deposits.
Enviros CCOT5 (0.5-1.5mbgl)	Made Ground	Associated with made ground at the coke ovens.
Enviros CCOT10 (0.0-1.2mbgl)	Made Ground	Associated with made ground at the coke ovens
Enviros WS11 (1.2-1.6mbgl)	Made Ground	Coke works – NAPL associated with perched groundwater at base of the made ground.
Enviros WS12 (0.5-0.8mbgl)	Tidal Flat Deposits	Biproducts Plant - NAPL associated with perched groundwater.
Enviros TP22 (0.7-0.9mbgl)	Made Ground	Coke Ovens - NAPL associated with perched groundwater at base of the made ground.
Enviros TP26 (0.7mbgl)	Made Ground	Engineering Shop - NAPL associated with perched groundwater at base of the made ground
Enviros TP29 (0.8-1.1mbgl)	Made Ground	Engineering Shop - - NAPL associated with perched groundwater at base of the made ground
Enviros TP30 (0.7-0.9mbgl)	Made Ground	Coke Ovens - NAPL associated with perched groundwater at base of the made ground
Enviros TP33 (0.2-0.5 and 1.0-1.mbgl)	Made Ground	Coke Ovens - NAPL associated with seepage in made ground and with relic structures.
Enviros TP34 (0.4-0.8 and 3.5-3.9mbgl)	Made Ground	Biproducts Plant - NAPL associated with seepage in made ground.
Enviros TP35 (0.5-0.8mbgl)	Made Ground	Biproducts Plant - NAPL associated with perched groundwater at base of the made ground
Enviros TP36 (0.9mbgl)	Made Ground	Biproducts Plant - NAPL associated with perched groundwater within made ground

H4.50 A plan showing the locations where NAPL was identified is presented in the Arcadis Environmental Site Assessment Report [Arcadis 2020 H5] as Appendix A of this report.

H4.51 Within the TLRS Area, no NAPL was noted within the two trial pits and one borehole advanced during the Enviros 2004 investigation (Enviros 2004 H15]. However, investigation by AEG (AEG 2018 H12] identified a tar like substance in 2 out of 44 intrusive locations.

Made Ground

Asbestos

H4.52 A total of 14 Made Ground soil samples from the western part of the North and West Quadrants around the former Cleveland Coke Ovens and Cleveland Steelworks were analysed for the presence of asbestos containing materials by Enviros in 2008 (Enviros 2008 H16]. No suspicious fibres or potentially fibrous materials were noted during the investigation which was confirmed by the laboratory analysis.

H4.53 However, during the recent Arcadis investigation [Arcadis 2020 H5] asbestos was identified in 31 samples of Made Ground collected from 110 trial pits and 10 boreholes located across the site (excluding the TRLS area) and were quantified at between <0.001 and 0.02%.

H4.54 Asbestos was detected in soil sampled from the TLRS area with AEG detecting asbestos in 35 soil samples collected from 44 intrusive locations which were quantified between <0.001 and 0.033% [AEG 2018 H12].

Metals and Inorganics

H4.55 With the exception of hexavalent chromium, the metals analysed were detected in the majority of the soil samples taken from the Made Ground. Statistical analysis undertaken by Arcadis [Arcadis 2018 H7, 2020 H15] indicates that the metal and inorganic ion distribution across the site within the three types of Made Ground deposit (slag dominant deposits, granular and cohesive Made Ground) are relatively consistent, within the same order of magnitude. Typically, metals concentrations were higher in slag dominant deposits and granular Made Ground compared to cohesive Made Ground.

H4.56 Detectable levels of cyanide and soluble sulphate were frequently detected across the site. Cyanide concentrations were typically higher in granular Made Ground and sulphate concentrations were on average higher in slag dominant Made Ground. The distribution of free cyanide measured in soil sampled from the site (inclusive of Enviros 2008, Shadbolt 2011 and Arcadis 2020) is provided on Figure 4 within the Arcadis Detailed Conceptual Site Model Review and Risk Assessment [Arcadis 2020 H1]. The maximum concentration of total cyanide and soluble sulphate within the TLRS Area [Arcadis 2018 H8] were 43mg/kg and 1,600mg/kg, respectively. The maximum total cyanide concentration was below the selected Generic Assessment Criteria (GAC).

H4.57 Soil samples ranged from alkaline 12.5 (slag dominant Made Ground) to neutral 7.5 (granular Made Ground) [Arcadis 2018 H7, and 2020 H15].

H4.58 Leachability testing showed the majority of metals were present in the leachate from Made Ground samples. Leached concentrations of metals were noted in all samples tested with arsenic, barium, magnesium, and manganese leaching in all samples. The pH of leachate samples was noted to generally be slightly alkaline and lower than the corresponding soil samples.

H4.59 Within the TLRS Area, [Arcadis 2018 H7, AEG 2018 H12], elevated concentrations of iron, chromium, manganese, vanadium, aluminium and other metals associated within iron and steel manufacturing were identified within all soil samples analysed with the exception of hexavalent chromium which was below detection limits. Cyanide and sulphate were also elevated with soil pH typically strongly alkaline (pH>10). Metals were noted to leach from all soil samples tested. The pH of leachate samples was noted to generally be close to neutral and lower than the corresponding soil samples.

H4.60 During investigation by Enviros within the TRLS Area [Enviros 2004 H15] the 95th percentile calculated for lead, zinc and sulphide was calculated at 531 mg/kg, 105 mg/kg and 2,099 mg/kg, respectively.

Polycyclic Aromatic Hydrocarbons

H4.61 The distribution of naphthalene measured in soil sampled from the site (inclusive of Enviros 2008, Shadbolt 2011 and Arcadis 2020) is provided on Figure 5 within the Arcadis Detailed Conceptual Site Model Review and Risk Assessment [Arcadis 2020 H1]. Concentrations of PAH were measured in 90 of the 101 samples analysed. The maximum concentration of naphthalene

within the TLRS Area [Arcadis 2018 H8] was 0.67 mg/kg which was below the GAC of 190mg/kg.

H4.62 Statistical analysis indicates that, within granular Made Ground, PAH concentrations were an order of magnitude higher than within slag dominant Made Ground. Concentrations of PAH measured in cohesive Made Ground were a further order of magnitude lower and where detected were measured at levels close to the method detection limit (MDL) [Arcadis 2020 H5], similar distribution was noted around the TLRS [Arcadis 2018 H7].

H4.63 Leached concentrations of PAH were measured in all samples analysed and comprised a broad range of both light, mid and heavy end compounds.

H4.64 Concentrations of naphthalene measured in soils in the south-west of the site were generally highest with the exception of soil sampled from Prairie_AUK_TP114 [Arcadis 2020 H1] which is located in the north of the site and recorded the highest concentration of naphthalene (37,000 mg/kg). Concentrations in the central and eastern areas were generally less than 1 mg/kg.

H4.65 No organic determinands were found at concentrations in excess of respective (historic) guideline values during investigation by Enviros in 2004 within the TLRS Area [Enviros 2004 H15], a review against standards in 2018 did not identify any determinands in excess of contemporary generic assessment criteria [Arcadis 2018 H8].

Petroleum Hydrocarbons

H4.66 Concentrations of TPH were detected above the MDL in approximately half of soil samples collected from the site (inclusive of Enviros 2008, Shadbolt 2011 and Arcadis 2020 investigations) with 10 samples reported concentrations of above 1,000mg/kg'. The maximum concentration of sum TPH within the TLRS Area [Arcadis 2018 H8] was 1,800 mg/kg with no TPH fractions above applicable GAC.

H4.67 Analysis of all elevated (>1,000mg/kg) TPH samples indicated TPH was primarily heavy end hydrocarbons with limited volatility which was supported by the low Photo Ionisation Detector (PID) readings measures in associated sub samples in the field. Leachability testing typically identified TPH in the leachate of these samples.

H4.68 Elevated TPH concentrations in Made Ground were identified in the vicinity of the former Coke Ovens, a former water treatment plant and associated with redundant services. The locations of elevated TPH C10 to C35 and extractable petroleum hydrocarbons C10 to C40 (EPH) in historical third party data are shown on Figure 13 of [Arcadis 2020 H5].

H4.69 No organic determinands were found at concentrations in excess of respective guideline values during investigation by Enviros in 2004 within the TLRS Area [Enviros 2004 H15].

Other Contaminants

H4.70 Low levels of VOC, SVOC, and PCBs were generally measured infrequently in soil samples although BTEX compounds and 2-methylnaphthalene were detected most often.

Superficial Deposits

H4.71 Concentrations of metals within the Superficial Deposits are relatively consistent between the different geological units [Arcadis 2020 H5]. Statistical analysis indicates metals concentrations were generally lower than those observed in Made Ground. Where PAHs or TPH were detected they were generally measured only marginally above the MDL with the exception of samples collected from pits where the overlying Made Ground showed signs of significant contamination.

Groundwater

H4.72 Seven wells are screened across the Superficial Deposits, four across bedrock and one across the Made Ground. A further two boreholes are located within the TLRS Area: one screened across the Made Ground and Glacial Till and one screened across the Glaciolacustrine Deposits.

TLRS Area

H4.73 Groundwater samples from the Made Ground and superficial deposits in Area A exceeded screening criteria for copper and manganese, and several PAH compounds. Contaminant concentrations were generally higher in standpipe screening the Made Ground as would be expected and this standpipe also recorded a marginal exceedance of the WQS for nickel. Dissolved aliphatic and aromatic petroleum hydrocarbons were detected in borehole S3-BHA02 screening the superficial deposits in the southwest of the site.

Dorman Point – Excluding TLRS Area

H4.74 Metals were measured in all groundwater samples; boron, calcium, manganese, sodium, and iron were measured at the highest concentrations [Arcadis 2020 H5]. Of note significantly elevated concentrations of barium were noted in Prairie_AUK_BH102 screened across the Made Ground, concentrations of manganese were also noted to be an order of magnitude lower in this location than elsewhere. Metals concentrations in the Superficial Deposits and bedrock were generally noted to be within the same order of magnitude.

H4.75 Elevated levels of sulphate and chloride were measured in all samples. The pH of the groundwater in wells screened across natural deposits was neutral to slightly basic and ranged between pH7.4 and pH9.2 with the majority of the samples showing a pH<8. Groundwater from monitoring well Prairie_AUK_BH102 screened across Made Ground measured pH12.5 (basic).

H4.76 Concentrations of TPH were measured in groundwater sampled from three monitoring wells: Prairie_AUK_BH104 (31µg/l), Prairie_AUK_BH109 (9,400µg/l) and Prairie_AUK_BH101S (40µg/l) [Arcadis 2020 H5]. Polycyclic aromatic hydrocarbons were the most frequent organic compounds detected measured in all monitoring wells at levels ranging from just above the limit of detection to 7,800µg/l Prairie_AUK_BH109.

H4.77 Low levels of VOC primarily alkyl benzene derivatives were identified in groundwater sampled from Prairie_AUK_BH109 and Prairie_AUK_BH101S.

Ground Gas

H4.78 Previous site assessments have not identified an unacceptable risk to human health or built receptors from the accumulation of ground gas. However, as ground investigations were not designed with a particular redevelopment scenario in mind, the gas data monitoring was limited and may not be representative of the entire extent of the site under a particular redevelopment. Additional ground gas monitoring at greater density is recommended prior to any specific redevelopment to determine the risk from ground gases on the site, the scope of this investigation would depend on the proposed redevelopment scenario.

H4.79 Six rounds of ground gas monitoring were undertaken from 16 locations across the western part of the North and West Quadrant around former Cleveland Coke Ovens and Cleveland Steelworks by Enviros in 2008 [Enviros 2008 H16]. The maximum methane and carbon dioxide concentrations were 1.3% v/v and 4.9% v/v. respectively, with flow rates negligible to low during the majority of visits with a maximum of 5.1L/hr. Hydrocarbon vapours measured by Flame Ionisation Detector (FID) were also generally low (<15ppm) although a maximum of 200ppm was measure on one occasional in a single location in the area of the for By-Products Plant.

Ground gas data was assessed by Enviros with reference the Construction Industry Research Information Association (CIRIA) Report C659 which has been updated since the time of this assessment but considered that a Characteristic Situation 2 would be appropriate which requires gas protection measures for new buildings. This assessment only relates to part of the site with ground conditions and the assessment approach likely to have changed since 2008.

H4.80 Within the TLRS Area, ground gas monitoring was undertaken within 2 locations by AEG over 4 rounds of monitoring between November 2017 and May 2018 (AEG 2018 H12]. The concentrations of methane and carbon dioxide were typically <0.1%v/v with a maximum for both gases of 0.2 % v/v with no measurable flow rate at either location during any visit.

Relevant Sensitive Receptors

H4.81 The following receptors have been identified for the site:

Table H4.4 Identified Receptors

Receptor	Phase	Sensitivity (as defined in Table H3.1)
	Construction	
Human Health Receptors		
Construction Workers	Applicable	Very High
Offsite Human Health Receptors	Applicable	Low to High
Environmental Receptors		
Surface Waters	Applicable	Medium
Groundwater	Applicable	Medium
Built Environment		
Waste Management Facilities	Applicable	Medium

Sources

H4.82 The following key sources have been defined within recent site and risk assessment work undertaken by Arcadis (Arcadis 2020 H1, H4 and H5] with regard development of the site:

1 **Non-Aqueous Phase Liquids (NAPL)** – NAPL, principally oils and tar like substances, has been identified within shallow Made Ground principally at the former Cleveland Coke Ovens and Biproducts Plant and in other isolated areas across the site. NAPL represents a primary and potentially long-term source of organic contamination (notably naphthalene) and, therefore, the removal and remediation of NAPL impacted material is an objective of the remediation strategy [Arcadis 2020 H4].

2 **Made Ground** –The site is known to contain significant Made Ground deposits comprising of slag, ash and demolition rubble giving rise to a range of contaminants including heavy metals, PAH, hydrocarbons, abnormal pH and sulphate/sulphides. The contaminants measured above Generic Assessment Criteria [Arcadis 2020 H5] protective of human health receptors were arsenic, and PAHs including naphthalene. Contaminants in Made Ground may also present risks to the built environment notably subsurface concrete and plastic water supply pipes.

3 **Hazardous Ground Gases** –While further assessment of current ground gas across the site is considered required, the presence of ground gases may present a risk to current and future onsite and offsite human health (e.g. asphyxiation) as well as onsite and offsite properties (e.g. explosion). Vapour inhalation of volatile contaminants has been assessed and is considered addressed via removal and remediation of NAPL impacted material;

4 **Asbestos** – Investigation data has identified the presence of asbestos in Made Ground which is likely to be derived from the historical industrial land use.

Source Pathway Receptor (SPR) Linkages

H4.83 Following completion of the Generic Quantitative Risk Assessment undertaken as part of the Environmental Site Assessment work by Arcadis [Arcadis 2020 Appendix H5] and the subsequent Detailed Conceptual Site Model Review and Risk Assessment [Arcadis 2020 Appendix H1] the potentially active pollutant linkages and contaminants of concern (CoC) in relation to human health risks have been identified within the CSM:

1 Vapour inhalation of indoor and outdoor air from naphthalene contamination associated with NAPL impacted material;

2 Dermal contact/ingestion of soil from arsenic, and PAHs including naphthalene associated with Made Ground and NAPL impacted material;

3 Dust inhalation of asbestos.

H4.84 Following completion of the Generic Quantitative Risk Assessment undertaken as part of the Environmental Site Assessment work by Arcadis [Arcadis 2020 Appendix H5] and the subsequent Detailed Conceptual Site Model Review and Risk Assessment [Arcadis 2020 Appendix H1] the potentially active pollutant linkages and contaminants of concern (CoC) in relation to environmental risks have been identified within the CSM:

1 Leaching of contaminants from made ground to surface water or groundwater receptors;

H4.85 Additional Source Pathway Receptor Linkages to be addressed by the remediation include:

1 Organic and inorganics contaminants in Made Ground such as sulphates, hydrocarbons, elevated pH may also present risks to the built environment notably subsurface concrete and plastic water supply pipes.

Future Baseline

H4.86 The site preparation and infrastructure installation (construction) is assumed to commence in 2021 and is assumed to take up to 6 months following granting of planning permission with the first floorspace delivered in 2022. The construction period is anticipated to total 11 years with completion anticipated in 2032.

H4.87 As described above in Section H4 (Existing Conditions), there are a number of potential on site sources of contamination as well as potential off-site sources. The identified contamination beneath the site to date predominantly relates to historic land use and it is considered that no significant deterioration in ground conditions will occur in the absence of development. There is currently no active use of the site.

H4.88 Demolition of remaining buildings (small relic Oxygen Plant, former Loco Repair Shop and the former TLRS) and other remaining infrastructure (notably the Coke Ovens Gas Main) will be subject to separate planning consents and are not considered within the ES. It is assumed that demolition works will be undertaken in accordance with all relevant permissions, guidance and legislation such that there are no significant impacts on ground conditions or remediation requirements.

H4.89 Therefore, existing baseline conditions with respect to geology, hydrogeology and land quality would be unlikely to change significantly between now and the completion of the works in the absence of the proposed development.

H5.0 Potential Effects

Embedded Mitigation

H5.1 The proposed embedded mitigation measures relevant to ground conditions include:

1 Earthworks: for the purpose of this EIA it is assumed that the construction stage of the development will be cut and fill neutral;

2 Site Levels: the proposed minimum finished floor level is 8.00m AOD (Parameter Plan, DP-SD-10.01).

3 Implementation of Construction Environmental Management Plan (the CEMP principles outlined in Section B7.0 of Chapter B will be conditioned and there will be a requirement to provide an updated and detailed CEMP for each development phase based on these principles);

4 Further site and ground investigation surveys will be undertaken in order to identify the need, or otherwise, for additional survey work and / or remediation work. This stage of work will include, if necessary, the submission of details to divert Holme Beck and Knitting Wife Beck;

5 All temporary construction works will be designed to meet engineering and health and safety standards;

6 Construction of construction compounds and waste, fuel and storage areas ahead of construction work commencing. Materials for active phase of development only to be stored onsite;

7 Hazardous and non-hazardous waste to be sent to the Highfield landfill site;

8 A piling risk assessment is to be prepared for each phase of development; and

9 The Outline Remediation Strategy, prepared by Arcadis [Arcadis 2020 Appendix H4], shall support further detailed remediation design work and outlines the approach to manage potential risks to identified receptors during site redevelopment. This is discussed further below.

Outline Remediation Strategy

H5.2 The aim of the remediation strategy [Arcadis 2020 H4] is to:

1 Remove underground relic structures and foundations;

2 Processing Made Ground materials in order to make suitable for use as engineering fill materials,

3 Make the site suitable for future commercial / industrial end-use through SPR linkage breaks from materials impacted with PAHs, asbestos, cyanide, and arsenic; and,

4 Reduce the geotechnical risks from slags and refractory materials removed as a consequence of the excavation works.

H5.3 The remediation strategy includes several elements which will mitigate potential environmental risks as part of the proposed remedial works, including:

1 Bulk earthworks to remove obstructions and segregate unsuitable or contaminated soils,

2 Treatment of soils or perched water contaminated with NAPL or other contaminants for reuse or removal from site as appropriate;

3 Processing made ground for reuse as secondary aggregate or engineered fill;

4 Installation of a capping layer to provide short term protection from dust or direct contact with contaminated soils.

5 Detailed design of each phase of development will incorporate a final capping layer to suit the development proposals and engineering controls to protect against aggressive ground conditions and ground gas (if required).

H5.4 These embedded mitigation measures have been taken into account during this assessment when assessing potential effects. Measures included in the Framework CEMP will not be repeated below or in Section H6.0: Mitigation and Monitoring.

Major Hazards and Accidents

H5.5 Major Hazards and Accidents have been considered in the assessment below. It is assumed that COMAH related risks would be removed during the demolition of the site. The main aspects are therefore considered to be explosion from UXO, land instability and risk from contamination. Mitigation is detailed, in Section G6.0, with regards to UXO and risk from contamination. With regards to land instability, this would be mitigated during the detailed design stage of the buildings / structures on site which would consider the ground conditions present. No significant effects from major hazards and accidents from a ground conditions perspective are considered likely.

Phasing

H5.6 Remediation and other measures to manage potential risks to identified receptors due to ground contamination and other ground conditions will be undertaken during the construction phase and therefore the subsequent phasing of future developments is not considered relevant for this chapter.

During Construction

Impacts on Human Health Receptors

H5.7 The use of heavy equipment and activities such as excavation, backfilling, and compaction may disturb the soil and result in dust generation as well as provide opportunities for direct contact and inhalation of contaminants. Made Ground covers the entire site footprint ranging in depth between 0.6 and >5.0 m bgl (below ground level) with the majority of the site covered by between 1 and 3m of Made Ground. Three types of Made Ground were noted: slag-dominant material, Granular Made Ground and Cohesive Made Ground. The contaminants measured above Generic Assessment Criteria [Arcadis 2020 H5] protective of human health receptors were arsenic, and PAHs including naphthalene.

H5.8 Excluding the TLRS area, asbestos was identified in a total 31 samples of Made Ground collected from 164 intrusive locations across the site quantified at between <0.001 and 0.02%.

H5.9 Asbestos was also detected in soil sampled from the TLRS area with AEG detecting asbestos in 14 soil samples collected from 44 intrusive locations which were quantified between <0.001 and 0.033% [AEG 2018 H12]. Asbestos is potentially hazardous when inhaled and therefore the inhalation of dust is considered an active pollutant linkage (Section H4.87) as surface soils may become airborne during construction or if incorporated into soft landscaping without any cover.

H5.10 NAPL, principally oils and tar like substances, have been identified with in shallow Made Ground around the former Cleveland Coke Ovens and Biproducts Plant and associated with redundant services at 21 locations across the site. NAPL represents a primary and potentially long-term source of organic contamination with potential human health exposure via vapour inhalation

(naphthalene constituent) and direct contact considered active pollutant linkages requiring removal and/or remediation.

H5.11 Based on existing survey data available, the sensitivity of the human receptors is very high for construction workers and low to high for off site human health receptors of surrounding properties. The magnitude of impact prior to mitigation but considering the embedded mitigation is medium to low (primarily due to areas not currently investigated). This could lead to impacts of worst case **Substantial Adverse** significance for construction workers (considered 'Significant' in EIA terms) and **Moderate Adverse** for off site human health receptors (considered 'Significant' in EIA terms) if additional mitigation actions are not carried out.

Environmental Receptors (Surface Waters and Groundwater)

H5.12 Assessment of the applicability of water resources associated with the site (groundwater in the underlying aquifers and surface water features) as receptors of concern was undertaken by Arcadis (Arcadis 2020 H1] using the additional site-specific data which is described in Section H4.19 and summarised below.

H5.13 Regarding groundwater, the industrial setting of the site, the low yielding / unproductive status of the superficial aquifer, that the site is not located with 1km of an SPZ and the potential for saline intrusion makes it unlikely that abstraction of the identified aquifers, especially for drinking water, would be desirable. On this basis, groundwater underlying the site is considered to be of low resource potential (e.g. low magnitude of effects, based on criteria in Table H3.2).

H5.14 Regarding the surface water features, concentrations of CoC measured in Holme Beck were generally less than the applicable EQS and the Holme Beck is hydraulically upgradient of the majority of the site, therefore, the risk to Holme Beck is considered to be low.

H5.15 Knitting Wife Beck and the Cross Connector are currently culverted. On this basis, provided that the culverts can be proven to be in good condition and that groundwater is not in continuity with the water in the culvert, the risk to Knitting Wife Beck and the Cross Connector from contamination is considered to be low. As noted above, should the Knitting Wife Beck and Cross Connector be diverted at a later stage, the risk of contamination is considered to be low, because they will either remain culverted across the site or opened up to flow within lined channels so, in either eventuality, will not be in hydraulic continuity with groundwater or soil leachate.

H5.16 The assessment of significance undertaken within this EIA supports the remedial strategy with the sensitivity of the controlled water receptors considered medium (reflecting a water receptor deemed to be of low value) and that given the low magnitude of likely impact the overall significance is considered Negligible and therefore Not Significant.

Impacts on the Built Environment

H5.17 For the purpose of this EIA process, it is assumed that the proposed development site will be cut and fill neutral (inclusive of capping layer) and that excavated material can be reused onsite to construct the development platform. The capping layer is also assumed to be constructed from site won material but may utilise a proportion of imported clean material if required. However, some excavated material may not be suitable for remediation or reuse and it is assumed that all hazardous and non-hazardous waste will go to the Highfield Landfill Site in the South Bank area.

H5.18 To meet BREEAM Very Good, contractors will consider using local suppliers, or sourcing materials from the Teesworks area and they will be required to implement a Site Waste Management Plan ('SWMP') which will be monitored throughout the construction period.

H5.19 The sensitivity of the built environment is medium and the magnitude of impact prior to mitigation is medium. This is due to the potential for soil/materials disposal required following earthworks resulting in a limited or minor increase in demand on waste management infrastructure and the potential for damage to buildings, structures or the environment. Thus, the impact on the built environment – principally waste management facilities, is considered to be of Minor Adverse significance which is considered 'Not Significant' in terms of this EIA assessment.

H5.20 Soil/materials disposal required following earthworks resulting in a limited or minor increase in demand on waste management infrastructure

H6.0 Mitigation and Monitoring

During Construction

H6.1 Embedded mitigation is detailed in H5.1 to H5.4 above which includes implementation of the approved outline remediation strategy, further investigation, a piling risk assessment and best practice detailed within the Framework CEMP. Additional mitigation is detailed below.

Remediation Strategy

H6.2 Based on the complexity of the site the most suitable option to manage materials and excavated materials is via an application in accordance with CL:AIRE guidance 'Definition of Waste: Development Industry Code of Practice' (DoWCoP). Therefore, a Materials Management Plan (MMP) shall be prepared in accordance with CL:AIRE DoWCoP and authorised by a Qualified Person registered with CL:AIRE. Excavated materials will be segregated and sorted into categories as defined in the remediation strategy [Arcadis 2020 H4].

H6.3 An Outline Remediation Strategy is included in the embedded mitigation above. This covers the majority of the site, however there are areas e.g., underneath existing buildings and structures which require further investigation to understand the ground conditions / contamination status, before a Remediation Strategy can be prepared. Therefore, once the further investigation has been undertaken, the exiting Outline Remediation Strategy would be extended to include these additional areas or a separate Remediation Strategy would be prepared and implemented to reduce the risks to identified sensitive receptors.

H6.4 The detailed design for each of the development plots will determine the detailed remediation approach based on the intended layout and form of development and further investigation and assessment. A detailed remediation strategy may be required for each phase and should be in accordance with outline strategy

Unanticipated Contamination

H6.5 In the event that contamination is encountered at any time when carrying out the remediation and reclamation works that was not previously identified, an investigation and a risk assessment will be undertaken and where remediation is considered necessary a remediation scheme will be prepared and agreed with the relevant authorities.

H6.6 Where unanticipated contamination is encountered within excavated material that is similar to that encountered elsewhere within the site, then the process set out below will be followed:

1 Sampling for, and undertaking chemical analysis;

2 Assessment of chemical data; and,

3 Sentencing for remediation and/or processing, as necessary.

H6.7 Where identified environmental contamination extends below 2.5m bgl, any requirement for deeper excavation works will be assessed on a case specific basis following consultation with stakeholders.

H6.8 The location of any such unanticipated contamination encountered will be recorded, including the results of chemical testing, the volumes sentenced for treatment by remediation, the validation data showing compliance with the relevant remediation objectives and the location of the area of use of the remediated material within the development platform.

Measures to Protect Human Health Receptors

H6.9 Based on the results of the previous ground investigations as well as any further investigation undertaken, areas that pose a risk to human health as a result of identified contamination would be delineated and remediated prior to construction works. Further assessments are recommended to include, but are not limited to, the following tasks which will identify the need for further mitigation.

- Additional ground gas monitoring at greater density is recommended prior to any specific redevelopment to determine the risk from ground gases on the site, the scope of this investigation would depend on the proposed redevelopment scenario.
- Previous assessment has identified a Medium risk of UXO for borehole and excavation activities. Further mitigation activities such as detailed risk assessment or site mitigations are considered essential to reduce the UXO risk on the site to As Low As is Reasonably Practicable (ALARP).
- Areas of the site are currently inaccessible e.g. beneath building footprints, beneath sumps, tanks and pipe work which require investigation during the earth works contract. If any contamination is identified this should be assessed and will require remediation/removal. Most notably in this regard is the TRLS building.

H6.10 As asbestos contaminated Made Ground is likely to be encountered during construction works, an appropriate Health and Safety Plan would be prepared to manage delineated materials in a safe manner in accordance with the Construction (Design and Management) Regulations 2015 and the requirements of the Control of Asbestos Regulations 2012.

H6.11 In the event that suspected materials are observed associated with excavations, sampling will be undertaken to confirm the asbestos type and quantification. Where ACM has to be removed to facilitate removal of structures it shall be separately stockpiled and covered to control potential dust generation. Soils containing asbestos will not be subject to mechanical screening where free fibres have been detected or are suspected. All soils containing gross asbestos will be managed by maintaining mist sprays to keep the soils wet whilst handled and covered when stockpiled.

H6.12 In the event that materials are impacted with visible fragments of ACM, the ACM materials shall be handpicked by a suitably licenced asbestos contractor with additional control measures implemented based on the sampling results. Where soils containing CoC in excess of the reuse criteria and, due to the presence of asbestos cannot be safely handled or successfully treated, they will be disposed of offsite. Where concentrations are below the reuse threshold soils may be reused as infill to excavation voids at depths below 0.6 m of final ground level.

H6.13 Asbestos should be presumed to be within all Made Ground deposits, and therefore will need to be included in piling risk assessment should piles be proposed.

Environmental Receptors (Surface Waters and Groundwater)

H6.14 If NAPL is encountered on the groundwater during excavation works, its recovery will be required prior to groundwater discharge. Recovery will continue until no visible NAPL is observed or further recovery is not reasonably practicable (evidenced by diminishing recovery quantities i.e., base of asymptotic curve). Where there is evidence of the presence of NAPL in the unsaturated zone, excavations will be extended to expose the groundwater table and identify if it is impacted by the above material and if groundwater treatment is required.

H6.15 During the remediation and reclamation works perched water in the Made Ground materials could contain elevated concentrations, in comparison to applicable discharge consent criteria or Environmental Quality Standards (EQS) of various metals (e.g., chromium, cadmium,

manganese, nickel, zinc), inorganic (e.g. ammonia, ammonium, sulphate) and organic (various PAHs) determinands and there is therefore a requirement for its collection and treatment prior to discharge.

H6.16 Where perched water encountered during the progress of the earthworks contains concentrations of determinands that would breach any consent/permit for discharge then the water shall be subject to pre-treatment. This treatment will be influenced by the nature of the exceedances and may include the use of the following treatment processes: settlement, flocculation, air stripping, aeration, chemical oxidation, granulated carbon adsorption. It is envisaged that an on-site treatment plant may be required to ensure that the concentrations of key determinands in the effluent discharge are within consented discharge limits.

H6.17 Excavated materials identified by laboratory analysis as chemically unsuitable for direct reuse will be stockpiled for treatment. Stockpile and treatment areas will be required to be placed on impermeable surfaces with covers and suitable drainage to collect and dispose of waters. Validation testing of these areas will be undertaken to prove the land quality pre- and post-remediation.

Impacts on the Built Environment

H6.18 The disposal of solid waste, contaminated or otherwise to landfill sites will be best mitigated by prevention or minimisation of the overall quantities of waste generated during construction and by ensuring that excavated material consigned to landfill is deposited within the existing adjacent Highfield Landfill. The remediation strategy [Arcadis 2020 Appendix H4] sets remediation / reuse criteria for materials to be used within the capping layer of the development. The strategy has been developed with the intention to minimise off-site disposal of materials.

H6.19 As part of the plan the records of all materials movements on-site and off-site will be kept by the Reclamation / Earthworks Contractor in paper and electronic format for a minimum period of 2 years following completion of the works and production of the Validation / Verification Report. To allow auditing of the Materials Management Plan; data will be stored electronically in a specifically designed database on site. Daily data uploads would be undertaken. All data would be geo-referenced and all stockpile sample nomenclature would ensure individual identification.

H7.0 Residual Effects

During Construction

Impacts on Human Health Receptors

H7.1 The sensitivity of human receptors (construction workers and offsite human health receptors) is very high for construction workers and low to high for off-site human health receptors. The magnitude of impact following mitigation identified in Section H6.0 is negligible. There are likely to be impacts of Minor Adverse significance for construction workers and Negligible significance for off site human health receptors after the implementation of mitigation measures. These effects are considered 'Not Significant' in EIA terms.

Impacts on Environmental Receptors (Surface Waters and Groundwater)

H7.2 The sensitivity of the surface water and/or groundwater is medium and the magnitude of impact following mitigation identified in Section H6.0 is negligible. Therefore, the impacts after the implementation of mitigation measures are considered to be of Negligible significance. This is considered 'Not Significant' in EIA terms.

Impacts on Waste Management Facilities

H7.3 The sensitivity of the waste management facilities is medium and the magnitude of impact following mitigation identified in Section H6.0 is Low and thus the impact on management facilities during the construction phase is considered to be of Negligible significance. This is considered 'Not Significant' in EIA terms.

H8.0 Summary & Conclusions

H8.1 A number of potential impacts of varying significance to receptors, associated with land quality, ground conditions and contamination have been identified. These potential impacts have been considered and assessed within the context of the proposed construction (including the proposed remediation works detailed in the remediation strategy [Arcadis 2020 H4]. The operational phase has been scoped out of assessment.

H8.2 The sensitivity of the human receptors (construction workers and residents/visitors of surrounding properties) is very high and low to high respectively while the groundwater and principal surface water feature (Holme Beck and Knitting Wife Beck) are considered of low value and hence considered medium sensitivity.

H8.3 There has been a number of previous intrusive investigations undertaken across the site involving significant scopes of geochemical and geotechnical assessment such that ground conditions and contamination at the site are considered to be well characterised. However, while a remediation strategy has been developed [Arcadis 2020 Appendix H4] there remain some outstanding data gaps and aspects of remediation design which require addressing prior to remediation and redevelopment.

H8.4 Mitigation that is designed to protect the identified receptors susceptible to impacts from contamination in Made Ground soils have been set out below in Table G8.1. The residual significance of the impacts identified is considered to be Minor Adverse / Negligible and Not Significant following the implementation of the mitigation measures.

H8.5 Table H8.1 summarises the impacts relating to Land Quality, Ground Conditions and Contamination.

Table H8.1 Summary of Impacts relating to Ground Conditions and Contamination

Receptor	Impact	Potential Effects (taking account of embedded mitigation)	Additional Mitigation and Monitoring	Residual Effects
During Construction				
Construction Workers and Offsite Human Health Receptor	Exposure to contaminated soils, asbestos fibres mainly during earthworks	**Substantial Adverse** - Construction Workers **Moderate Adverse** – Off Site Human Health Receptor **Significant**	Extension to Remediation Strategy, Unforeseen Contamination, Additional ground gas monitoring, Detailed UXO risk assessment, Investigation beneath building footprints, Asbestos best practise NAPL recovery where necessary	Minor Adverse – Construction workers Negligible – Off Site Human Health receptors Not Significant
Surface Water Groundwater	Potential leaching of contaminants impacting the groundwater / surface water	Negligible and Not Significant		Negligible and Not Significant
Built Environment: waste facilities	Soil/materials disposal required following earthworks resulting in a limited or minor increase in demand	Minor Adverse	Minimisation of waste materials generated Material disposed in Highfield Landfill Materials Management Plan	Negligible and Not Significant

H9.0 Abbreviations & Definitions

1	AOD	Above Ordnance Datum
2	BOS	Basic Oxygen Steelmaking
3	BGS	British Geological Society
4	C4SL	Category 4 Screening Levels
5	CSM	Conceptual Site Model
6	CEMP	Construction Environmental Management Plan
7	DEFRA	Department Environment Food and Rural Affairs
8	DPD	Development Plan Document
9	EA	Environment Agency
10	EPR	Environmental Permit Regulations
11	ES	Environmental Statement
12	GAC	Generic Assessment Criteria
13	HFO	Heavy Fuel Oil
14	MMP	Materials Management Plan
15	NPPF	National Planning Policy Framework
16	PPE	Personal Protective Equipment
17	PAH	Polycyclic Aromatic Hydrocarbons
18	RCBC	Redcar and Cleveland Borough Council
19	SVOC	Semi Volatile Organic Compounds
20	SNCI	Sites of Nature Conservation Interest
21	SLEMS	Solid Liquid Effluent Management Site or South Lackenby Environmental Management System
22	SPR	Source Pathway Receptor
23	STDC	South Tees Development Corporation
24	TEM	Toluene Extractable Matter
25	TPH	Total Petroleum Hydrocarbons
26	VOC	Volatile Organic Compounds

H10.0 References

National Policies and Legislation

1 Environmental Protection Act 1990 Part II;

2 Environment Act 1995;

3 Environment Agency 2008, An ecological risk assessment framework for contaminants in soil. Science Report SC070009/SR1;

4 Derivation and use of soil screening values for assessing ecological risks Report – ShARE id26 (revised);

5 BRE Special Digest (SD) 1: Concrete in Aggressive Ground, 2015;

6 Environmental Permitting (England and Wales) Regulations 2010;

7 Control of Pollution (amendment) Act 1989;

8 Water Framework Directive 2000/60/EC;

9 Groundwater Directive 2006/118/EC;

10 Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991 (as amended);

11 Controlled Waste (England and Wales) Regulations 2012;

12 Construction (Design and Management) Regulations 2015;

13 Hazardous Waste (England and Wales) Regulations 2005;

14 Waste (England and Wales) Regulations 2011;

15 Waste Framework Directive 2008/98/EC (OJEU, 2008);

16 The Contaminated Land (England) Regulations 2006;

17 The Environment Damage (Prevention and Remediation) Regulations 2015;

18 National Planning Policy Framework, 2019;

19 Environment Agency, Guiding Principles Land Contamination (GPLC2)

20 Environment Agency, Land Contamination Risk Management (2019);

21 Environment Agency, Land contamination groundwater compliance points: quantitative risk assessments, 2017;

22 Environment Agency, Protect groundwater and prevent groundwater pollution, 2017;

23 Environment Agency, Groundwater protection technical guidance, 2017;

24 Environment Agency, The Environment Agency's approach to groundwater protection, 2018;

25 British Standards 10175:2011+A2:2017 'Investigation of Potentially Contaminated Sites - Code of Practice' 2017;

26 British Standards BS3882:2015 'Specification for Topsoil and Requirements for Use' 2015;

27 British Standards BS EN 206:2013+A1:2016 'Concrete - Specification, Performance, Production and Conformity' 2013;

28 BSI Standards Publication "Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings", BS 8485:2015+A1:2019;

29 CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings' 2007;

30 CIRIA C552 Contaminated Land Risk Assessment A Guide to Good Practice. 2001;

31 CIRIA C692 Environmental Good Practice on Site. 4th Edition 2015;

32 National House Building Council, Environment Agency and Chartered Institute of Environmental Health 'R&D Pub 66: Guidance for the Safe Development of Housing on Land Affected by Contamination (Volumes 1 & 2), 2008;

33 National House Building Council, Guidance on Evaluation of Development Proposal on Site Where Methane and Carbon Dioxide are Present Report Edition No.4 March 2007;

34 EA's 'TR P5-065/TR: Technical Aspects of Site Investigation (Volumes 1 & 2)' 2002;

35 DEFRA (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance; and DEFRA Guidance, Pollution Prevention for Businesses, July 2016 (Updated May 2019).

Previous Environmental Reports

36 Former Steelworks Land, South Tees Outline Remedial Strategy, Prepared for South Tees Development Corporation by Wood, Ref 41825-wood-XX-XX-RP-OC-0001_S0_P01 dated 25th June 2019 [Wood 2019];

37 The Former SSI Steelworks, Redcar: Former SLEMS Landfill, Intrusive Investigation Report, prepared by Arcadis for South Tees Site Company Ltd., Ref Redcar Steelworks-AUK-XX-XXRP-GE-001-P1-SLEMS_BOS_Oxide_Assessment dated January 2019 [Arcadis 2019];

38 The Former SSI Steelworks, Redcar: Replacement CLE3/8 Landfill Boreholes, CQA Validation Report, prepared by Arcadis for South Tees Site Company Ltd., Ref 37774100007_01, dated January 2019 [Arcadis 2018];

39 TS4 South Bank – Phase 1 Environmental Desk Study, prepared by CH2M Hill for the Homes and Communities Agency, Ref. 678079_TS4_001 dated August 2017 and marked Final [CH2M 2017];

40 First Phase Reporting of the Site Protection and Monitoring Programme, prepared by Corus Group Plc (Corus [2008];

41 Design of a Site Protection and Monitoring Programme for Cleveland Works, Teesside, prepared by Corus Group Plc [Corus 2004];

42 Soil and Groundwater Baseline Characterisation Study, Teesside Works, prepared by Enviros for Corus UK Ltd [Enviros 2004], Comprising:

Volume 1 – Factual Report, Ref. Rlp250604corusteessidefactual.Doc dated 25th June 2004 and marked Final;

Volume 2 – Interpretive Report Ref. Mwicorusdraftinterpretivemmdv#2.Doc dated 25th June 2004 and marked Final; and,

Volume 3 – Summary Report dated June 2004.

43 South Tees Industrial Area – Site C – Ground Investigation, prepared by Allied Exploration and Geotechnics Ltd. for English Partnerships, Ref 1715H dated 12th July 1999 and marked Draft [AEG 1999].