ARCADIS Design & Consultancy for natural and built assets

THE FORMER SSI STEELWORKS, REDCAR: PRIORITY AREAS WITHIN SSI LANDHOLDINGS CONTRACT

Contract 3: Ground Remediation Options Appraisal Report (Prairie Phase 4 / TLRS Area)

South Tees Development Corporation

REPORT NO Redcar Steelworks-AUK-XX-XX-RP-GE-0001-02-SSI3_GI_ROA

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The Former SSI Steelworks, Redcar: Priority Areas within SSI Landholdings Contract

Contract 3: Remediation Options Appraisal Report (Prairie Phase 4 / TLRS Area)

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01	December 2018	As above	First Draft
02	February 2021	As above	Prairie Phase 4 / TLRS area only, updated in line with wider Prairie site 10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy

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1 INTRODUCTION

1.1 Contract Details

Arcadis (UK) Limited (Arcadis) were appointed by South Tees Site Company Limited (STSC) to conduct a remediation options appraisal to address environmental and geotechnical development constraints relating to ground conditions identified by the physical ground investigation works conducted at the SSI Landholding (external to buildings), Redcar (Contract 3, Areas A and B), the site.

The work was carried out in accordance with the "Ground investigation consultancy services former Iron and Steel Works Site, South Tees" contract (Ref: STSC-JN-0007) dated 14 September 2017.

Figure 1 in Appendix A provides details of the facility location and the site investigation area (note SSI3B is excluded from this report, see below).

This report has been updated in February 2021 at the request of South Tees Development Corporation (STDC) to support a detailed Planning application for the redevelopment of SSI3A Area now known as Prairie / Dorman Point Phase 4 which included the Torpedo Ladle Repair Shop (TLRS). The principle changes are:

- Removal of the BOS / CONCAST Area (SSI3B) not intended to be covered by the Planning application; and,
- Strategy updates in line with the Remedial Options Appraisal and Strategy Report for Phases 1-3 of the Prairie / Dorman Point Site (10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy).

1.2 Project Aims and Objectives

The overarching aim of the works was to deliver a sustainable ground remediation strategy for the contract sites which is compliant with regulatory needs (Local Authority and Environment Agency) and has their approval in principle. As technical consultant, the specific objectives of this phase of works were to review the output of the environmental and geotechnical risk assessment and identify applicable remediation options for the site.

1.3 Report Aims

The aim of this remediation options appraisal (ROA) is to use the available information to assess feasible remediation strategies to address the active source-pathway-receptor linkages identified by the site condition report and the development constraints identified by the geotechnical risk assessment within the conceptual site model (CSM) for the contract area in order to develop the final remediation technology selection and design.

1.4 Previous Information

The following reports have been prepared by AEG and Arcadis relating to SSI3:

- Enviros, Corus UK Ltd. – Soil and Groundwater Baseline Characterisation Study Teesside Works – Interpretative Report Volume 1, 2 and 3, June 2004
- CH2M, TS3 Grangetown Prairie – Phase 1 Geo-environmental Desk Study prepared for the Homes and Communities Agency (CH2M Reference Number 678079_TS3_001, dated August 2017), and;
- CH2M, SSI3 Redcar Works – Phase 1 Geo-environmental Desk Study prepared for the Homes and Communities Agency (CH2M Reference Number 678079_SSI3_001, dated August 2017).
- AEG, The Former SSI Steelworks, Redcar – Ground Investigation Contract – Priority Areas Within SSI Landholdings Contract 3, dated June 2018;
- Arcadis, The Former SSI Steelworks Redcar: Priority Areas Within SSI Landholdings Contract – Contract 3 Site Condition Report (SCR), Redcar Steelworks-AUK-XX-XX-RP-GE-0001-P1-SSI3_GI_SCR, dated May 2018;

- Arcadis, The Former SSI Steelworks Redcar: Priority Areas Within SSI Landholdings Contract – Contract 3 Environmental Risk Assessment (ERA), Redcar Steelworks-AUK-XX-XX-RP-GE-0001-P1-SSI3_GI_ERA, dated August 2018 ; and
- Arcadis, The Former SSI Steelworks Redcar: Priority Areas Within SSI Landholdings Contract – Contract 3 Geotechnical Risk Assessment (GRA), Redcar Steelworks-AUK-XX-XX-RP-GE-0001-P1-SSI3_GI_GRA, dated November 2018.

This ROA should be read in conjunction with the aforementioned reports.

1.5 Reliability / Limitations of Information

A complete list of Arcadis' Study Limitations is presented in Appendix B.

It should be noted that ground conditions between exploratory holes may vary from those identified during this ground investigation; any design should take this into consideration. It should also be noted that groundwater levels may be subject to diurnal, tidal, seasonal, climatic variations and those recorded in this report are solely dependent on the time the ground investigation was carried out and the weather before and during the investigation.

2 Relevant Environmental and Geotechnical Development Constraints

2.1 Proposed Redevelopment

No detailed redevelopment design is currently available for the site. This ROA has been conducted on the assumption that the any redevelopment of the site will be for a generic commercial / industrial end use. Remediation technologies have been selected based on Arcadis' professional judgement and experience of large scale redevelopments of brownfield sites. The site is part of a wider STDC Prairie / Dorman Point landholding and Arcadis recommends the remediation approach to the Prairie Phase 4 landholding is considered holistically with the wider redevelopment of the Landholding.

2.2 Development Constraints

Environmental

The site condition report (SCR) developed a conceptual site model (CSM) based on ground investigation findings. The CSM identified a number of potentially active source-pathway-receptor (SPR) linkages the significance of which was assessed within the environmental risk assessment (ERA). The identified SPR linkages were:

- Human Health - Risk to commercial workers via inhalation of asbestos fibres, originated from shallow Made Ground across the site.
- Risk to groundwater resource receptors through leaching of contaminants of concern (CoC) including metals, and polyaromatic hydrocarbons (PAH) to groundwater were identified by the ERA. A potential pollutant linkage into the deeper bedrock aquifers was also considered to be potentially active.
- Nearby surface waters may potentially be impacted by contamination in shallow groundwater. Surface water features near to the TLRS are culverted and less likely to be in continuity with groundwater.

The identified SPR linkages are shown within the CSM presented as Figure 2 in Appendix A.

For Phases 1-3 of the Prairie site remediation was not considered required to address risks to Controlled Waters in line with the conclusions of section 9.2 of the risk assessment 10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment. Arcadis consider this assessment is appropriate for Phase 4.

Ground Gas

The ERA did not identify an unacceptable risk to human health or built receptors from the accumulation of ground gas. However, as the SCR investigation was not designed with a particular redevelopment scenario in mind, the gas data monitoring was limited and may not be representative of the entire extent 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. Arcadis understand from STDC that it is expected this would be the responsibility of the developer.

Geotechnical

It is not the specific intention of this ROA to address geotechnical risks however these works have identified the following which may present significant development constraints at the site:

- Expansive slag deposits may lead to disruption and damage of structures, hardstanding etc.;
- Due to long term creep settlement, the Made Ground and underlying Tidal Flat Deposits may possess inadequate bearing capacity to support proposed structures;
- Lateral and vertical changes in ground conditions;
- Anticipated total and differential settlement / heave in excess of the tolerable limits may occur due to changes in loading or groundwater regime;

- Potential collapse or inundation settlement as a result of surface water infiltration and groundwater movement;
- Sulphate attack on subsurface concrete (including existing foundations if building is to be retained);
- Mitigation of any identified ground gas risk (subject to additional monitoring);
- Obstructions within the made ground (boulder size fragments of slag and buried underground structures), including a solidified torpedo ladle; and,
- No magnetic anomalies were identified during the intrusive works on Prairie Phase 4 however should redevelopment require the installation of piled foundations or deep ground improvement, clearance of locations for potential unexploded ordnance (UXO) is recommended.

2.3 Proposed Redevelopment and Enabling Works

No detailed redevelopment design is currently available for the site. Arcadis understand STDC are to complete enabling works to create an environmentally suitable development platform for future redevelopment. These works will include turnover of the Made Ground within the subsurface to a depth of up to 2.5 m bg) (assuming ground level is the foundation level) including removal and crushing of relic structures and obstructions, removal and treatment of environmental contamination as required and replacement of treated material to formation levels for development.

In some areas of the Site large relic structures are expected, where these or identified environmental contamination extend below 2.5m bgl, any requirement for deeper excavation works will be assessed on a case specific basis following consultation with stakeholders.

Anticipated maximum excavation depths are shown on Figure 3 in Appendix A.

It is not STDC's intention to remove piles to depth, excavate slag deposits below 2.5m bgl, or address the potential for future slag expansion. The preparation of a geotechnically suitable development platform for a specific redevelopment is the responsibility of the developer.

2.4 Materials Management

Given that remediation measures may involve the movement of materials around the Prairie Phase 4 site and the wider Teesworks site it is important that they are not classified as a waste (as defined by Waste Framework Directive) on completion of the works.

2.4.1 Achieving Non-Waste Status

There are several different waste regulatory options available, the suitability of which is dependent upon the complexity of the site and the quantity/composition of the material to be reused. Based on the complexity of the site Arcadis recommend the most suitable option is via an application in accordance with CL:AIRE guidance 'Definition of Waste: Development Industry Code of Practice' (DoWCoP).

2.4.2 Definition of Waste: Development Industry Code of Practice

The Environment Agency (EA) has worked with industry through CL:AIRE to prepare the DoWCoP (Definition of Waste: Development Industry Code of Practice The purpose of the DoWCoP is to allow industry to regulate itself with respect to determining whether excavated materials have achieved non-waste status. The EA states that 'When a signed Declaration is sent to us (the EA) by a Qualified Person showing that excavated materials are to be dealt with as set out in the DoWCoP, we (the EA) will take the view that the materials on the site where they are to be used will not be waste.'

If materials are dealt within in accordance with the DoWCoP then the materials are unlikely to be waste. This is either due to the fact that the materials were never discarded in the first place or because they have been submitted to a recovery operation and have been completely recovered so that they have ceased to be waste.

In order to demonstrate that the four factors have been fulfilled will require preparation of various reports including:

- Site investigation report (Site Condition Report / Environmental Site Assessment).

- Quantitative Risk Assessment (QRA);
- Remediation Strategy or Design Statement;
- Materials Management Plan (MMP); and,
- Verification report (on completion of the works).

In addition to the risk assessment, an MMP will be required detailing where soils will be moved to and how they will be tracked. Approvals will also need to be sought from the Local Authority and the Environment Agency (groundwater team) with respect to the remediation strategy. Planning permission may also be required.

Once this documentation is in place a Qualified Person will review the overall strategy and ensure that everything is in place prior to submitting a formal declaration to the Environment Agency (waste team), via CL:AIRE (the scheme administrators). On completion of the work a verification report will need to be completed.

2.4.3 Materials Management Plan

An 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 the following categories:

- Materials suitable for re-use on site (without needing additional treatment);
- Materials that require treatment in order to be suitable for re-use on site;
- Soils that require off-site disposal/treatment (not treatable);
- Refractory bricks and potentially expansive slag materials,
- Soils containing asbestos for treatment and reuse or for off-site disposal;
- Excavated hard materials (such as concrete and brick) that may be crushed to produce suitable material for use as infill in the Work; and
- Other materials that require off-site disposal (household waste, electrical goods, vegetation etc).

Where appropriate, existing concrete, brick and other suitable building materials will be crushed as specified by the Highways Specification to allow for reuse on-site. Materials destined for re-use must meet the criteria proposed within the MMP.

For site-based contaminants the Re-use Criteria and Assessment Criteria proposed are based on those developed following the Detailed Quantitative Risk Assessment conducted for Phase 1-3 of the Prairie site (10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment).

3 Remediation Objectives and Criteria

The aim of the remediation works at the site is to address the development constraints and to facilitate redevelopment for a generic future commercial / industrial end use.

3.1 Remediation Objectives

The remediation objectives will be achieved by controlling or breaking the identified SPR linkage in order to mitigate identified risks to the identified environmental receptors. The remediation objectives are to:

- Remove the potential for asbestos fibres to become airborne via dust generation at the site.
- Maximise the reuse of excavated soils by making them suitable for use under DoWCoP.
- To develop an unexpected contamination strategy in order to mitigate the risks of presented in the preparation of historical brownfield land.

3.2 Excavation Objectives

As the enabling earthworks are to be conducted alongside the environmental remediation it is considered prudent to incorporate the objective of the earthworks into the ROA. The enabling earthworks objective are to:

- Remove sub-surface obstructions within the Made Ground to a depth of 2.5m bgl. Where obstructions extend below this depth their removal will be conducted on a case by case basis following consultation with stakeholders;
- Creation of a formation layer suitable for a generic commercial / industrial redevelopment;
- Manage perched and confined groundwater within the Made Ground encountered during excavations;
- Management of risk to external hardstanding, culverted waterways and utilities; and,
- Development of a UXO mitigation strategy.

Arcadis recommends the following excavation objectives are considered as part of the earthworks strategy and therefore require consideration as part of the ROA:

- Consideration of the management and placement of expansive slag deposits and refractory materials excavated as part of the enabling earthworks; and,
- Protection of sub surface structures and utilities from attack due to aggressive ground conditions;

The excavation objectives are considered as part of this ROA but the specific options associated with the required process are not formally assessed.

It is not the intention of this ROA to fully address geotechnical development constraints at the site as these are the responsibility of the developer and dependent on a specific redevelopment scenario.

3.3 Remediation Selection Criteria

The selection procedure broadly follows the design making process outlined by the Construction Industry Research and Industry Associates (CIRIA) and incorporates issues raised by the Environment Agency for the selection of remediation strategies. The site-specific objectives are broken down into the following areas:

- Contamination Related Objectives

Site-specific constraints on the remediation strategy are also considered.

The objectives are prioritised in order to reconcile any potential conflicts, and a ranking procedure is used to identify and evaluate potential remediation options. The remediation design selection procedure involves the following stages:

- **Stage 1**: Review of the available technologies and a preliminary assessment of their suitability.
- **Stage 2**: Identification of appropriate technologies. Each technology is evaluated for the site-specific conditions by attaching a value from zero to three (value three represents the most favourable conditions).

- **Stage 3**: Evaluation of appropriate technologies. The capability of the technology to fulfil the defined objectives is weighted relative to the operational requirements of the system.

Following the identification and evaluation of the appropriate technologies, professional judgement is applied to the final design of the remediation strategy. This involves incorporating the design decisions along with principles such as practicability, effectiveness, durability and efficiency in order to determine the most appropriate strategy for tackling the pollution linkage / geotechnical constraint identified at the site.

3.4 Site Remediation Criteria

The site Remediation Criteria are:

- To break the identified pollutant linkage identified between asbestos in shallow Made Ground such that that exposure pathway for on-site commercial workers are inactive;
- To provide indicative solutions for the remediation of unexpected contamination in excess of screening levels identified in the Detailed Quantitative Risk Assessment conducted for Phase 1-3 of the Prairie site (10035117-AUK-XX-XX-RP-ZZ-0088-01-Prairie_Risk Assessment) which is considered appropriate for the Phase 4 area.

4 Remediation Technique Selection – Stage 1

Review of the available technologies and a preliminary assessment of their suitability

4.1 Stage 1 - Technical Feasibility

The first stage of the selection process is review and consideration of a wide range of remediation techniques, and use of a ranking system to select those techniques that are most feasible given the following factors:

- Contaminant Properties (including aggressive ground);
- Extent of Contamination; and,
- Geology/Hydrogeology.

Each remediation technique is ranked with a score of 0 to 3 on its technical feasibility given the above factors; the results are combined to provide a single Technical Score and, therefore an overall Technical Ranking. The scoring rationale is as follows:

- Technology not suitable;
- Technology may work (50%);
- Technology will probably work (70%); and
- Technology very suitable (>90%).

Table 1 provides an evaluation of the technical suitability of the potential remediation strategies. Where a remediation technology has been identified as being technically unsuitable, it has been eliminated further from the options appraisal and not been considered in terms of commercial and operation suitability.

4.2 Contaminant Properties

Environmental Receptors

The asbestos identified within the Made Ground was primarily in the form of free fibres. The asbestos was present at levels up to 0.034% by mass.

4.3 Extent of Contamination

The extent of contamination is summarised below based on the findings of the SCR and ERA. Given the size of the site sampling was conducted on a grid to provide an appropriate level of resolution of contaminant distribution for risk assessment and remediation design purposes.

During the implementation of any remediation approach additional testing is likely to be required to refine the contaminant distribution and maximise the efficiency of remediation implementation.

Environmental Receptors

The current potential extent of asbestos in soil has been identified, based on the soil sample analysis completed to date. The asbestos distribution across the site is shown on Figures 4 (Appendix A) respectively.

4.4 Geology/ Hydrogeology

The geological and hydrogeological setting is considered when assessing whether a remediation method is technically feasible. The physical properties of the geology (such as the permeability and porosity) alongside knowledge of the groundwater regime are combined within the ranking process. The geology and hydrogeology of the site are presented in the SCR.

4.5 Summary

The remediation techniques with the highest potential for success to address the environmental and geotechnical remediation objectives given the contaminant properties and ground conditions beneath the site are presented in Table 1 below and in Appendix C:

Table 1: Summary of Soil Treatment Technologies (Environment): Technical Parameters

	Hand Picking	Excavation and Disposal	Capping in situ	
Contaminant Properties	0	3	3	0 -Technology not suitable 1- Technology may work (50%) 2 -Technology will probably work (70%) 3- Technology very suitable (90% +)
Geology / Hydrogeology Suitable	2	3	3	0 -Technology not suitable 1- Technology may work (50%) 2 -Technology will probably work (70%) 3- Technology very suitable (90% +)
Extent of Contamination	0	3	3	0 -Technology not suitable 1- Technology may work (50%) 2 -Technology will probably work (70%) 3- Technology very suitable (90% +)
Technical Score	**2**	**9**	**9**	
Technical Ranking	**3**	**1**	**1**	

Two techniques have been identified as technically suitable to further reduce or manage the asbestos beneath the site and therefore will be considered in Stages 2 and 3 of the ROA process.

- Soil
  - Excavation and disposal
  - Capping in situ

5 Remediation Technique Selection – Stage 2 & 3

The second and third stages of the selection process builds consideration of additional key factors (commercial and operational) into the options appraisal process, using a ranking system which includes the following factors:

- Operational requirements - The operational requirements for each remediation technology have been assessed and scored based on how demanding the technology is with regard to technical plant, electrical power required etc.
- Permissions / permits - Each remediation technology has been considered with respect to likely requirements for operational permission/permits.
- Engineering considerations - The rate of success for application of each remediation technique, primarily based on experience from across the UK and US, is provided with an appropriate score.
- Residual liability - Residual environmental liability is a key consideration in the development of the remediation strategy. STSC would like to retain the land for a future commercial / industrial use and, therefore, require their liabilities associated with site to be reduced as far as practicable such that the site can be redeveloped for the chosen end-use.
- Commercial availability - The need for specialist equipment, and whether the equipment is readily available in the UK, is considered when assigning a score to each remediation technique.
- Remediation timescale - The risk management options have been assessed giving a higher score to technologies which address the development constraints rapidly.
- Capital, Operation and management cost - The likely capital, operation and management costs associated with each technique are considered when assigning a score.

Each remediation technique is ranked with a score between 1 to 3 given its likely suitability. The tables in Appendix D provide an evaluation of the operational and commercial suitability of the potential remediation strategies.

5.1 Operational Implementation

The site is no longer occupied, although the majority of the footprint is covered with roadways, car parks, and existing buildings and services which have the potential to constrain intrusive remediation activities.

Whilst clearing the site footprint of above ground structures would make implementation of remediation operations easier, it is also important that remediation operations do not have an adverse effect on the site or immediate surrounding area (e.g. noise, dust, traffic).

Completion of the proposed remediation activities has therefore been considered assuming above ground structures at the site are both retained and, demolished to allow redevelopment. It is envisaged extensive remediation earthworks could be completed more easily without buildings or other above ground structures in place.

5.2 Summary

Based on the results of the ranking process, each technology has been given a final technical, operational and commercial score and, therefore, an overall ranking. The output of the ranking process has been used to develop the likely remediation strategies for the site.

The top selected technologies for soil and groundwater respectively are presented below and discussed in Section 6.

- Asbestos
  - Excavation and disposal
  - Capping in situ

6 Discussion of Selected Remediation Technologies

This section presents a brief review of the selected remediation technologies which were highlighted as the most likely to be technically, operationally and commercially feasible to meet the remediation objectives at the site.

6.1 Excavation and Disposal

Excavation and disposal involves the removal of contaminant material from site and disposal at an appropriately licensed waste management/treatment facility. Imported material is used to backfill the excavation. The scope of the excavations would be dependent on the redevelopment scenario.

To mitigate the asbestos risk the amount of material requiring excavation and disposal would be dependent on the redevelopment plans for the Prairie Phase 4 Area.

Excavation of saturated Made Ground deposits is possible but would require additional dewatering operations. The majority of the Made Ground deposits at the site are considered to be unsaturated.

Advantages:

- Soil excavation will address all the asbestos identified in the shallow unsaturated soils;
- Contaminant hot spots identified as part of redevelopment can be excavated rapidly; and
- Would allow simultaneous removal of obstructions within the Made Ground;

Disadvantages:

- Excavation and off-site disposal of impacted soils to landfill will involve significant vehicle and traffic movements on and off-site, and likely affect neighbouring residents;
- Below ground utilities on-site may be affected and require replacement;
- Groundwater management and treatment may be required where excavation of saturated Made Ground is required;
- Although there may be scope to re-use excavated material elsewhere on the STSC site plant, haulage, and disposal costs would still be significant;
- Excavation activities can lead to excessive noise, dust and odour generation without proper controls; and,
- Large scale excavation and disposal (landfilling) is not considered to be a sustainable remediation approach.

6.2 Capping in Situ

Capping in situ is a process whereby a barrier is placed between the contaminated material and the receptor in order to break the exposure pathway. The cap design would be dependent on the redevelopment scenario but would likely include a geotextile liner overlain by clean imported material. Encapsulating material below new infrastructure (such as additional roads or car parks) constructed as part of any redevelopment would also be considered an appropriate capping method.

Advantages:

- Capping will address all the asbestos identified in the shallow unsaturated soils;
- Minimises exposure to construction workers during remediation activities as material is left in situ; and,
- Sustainable remediation approach.

Disadvantages:

- Contaminated material remains on site and therefore liability is retained;
- The lifespan of the cap will likely be significant but may need replacement in the future;
- Future ground works will need to be planned to avoid breaching the cap; and
- A cap would be installed based on a specific redevelopment scenario, additional remediation works may be required if additional redevelopment occurs in the future;

6.3 Management of NAPL.

The ground investigations conducted at the site have not identified the presence of non-aqueous phase liquids (NAPL). Should these be encountered during the remediation and enabling earthworks they will be removed and treated in line with the remediation strategy for Phases 1-3 of the Prairie site (10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy), an approach accepted as part of Planning decision R/2020/0318/FFM.

6.4 Management of Potentially Expansive Slags and Refractory Materials

It is beyond the scope of this ROA to assess technologies to manage expansive slag and refractory materials as these are to be the responsibility of the developer and tailored to a specific redevelopment scenario. However, if slag rich or refractory materials are required to be excavated as part of the enabling works either to facilitate removal of contamination and / or relic structures the following management approach is recommended.

6.4.1 Excavation, Separation and Reuse

This approach involves the excavation of the slag rich or refractory materials, the material is crushed, screened and before being re-used on site in areas considered by STDC to be low risk (eg. green corridors or biodiversity enhancement areas). Screening would involve the separation of slag dominant material from other Made Ground; laboratory testing could then be used to separate higher risk steel slag deposits from those comprised of blast furnace slag.

It may be possible to accelerate the expansion of slags by crushing and hydration however this has not been considered at this point within this assessment.

Advantages:

- Risks from expansive slag can be reduced
- Material can be sustainably reused on site as part of the redevelopment;
- Contaminant hot spots identified as part of redevelopment can be excavated rapidly; and,
- Would allow removal of obstructions within the Made Ground.

Disadvantages:

- Screening and separation of materials would require additional plant and analysis costs;
- Given the mixed nature of the slag deposits on site, segregation may not be capable of removing all of the slag and refractory materials. This may therefore reduce the magnitude of expansion but will not fully remove the risk.
- Significant tracking will be required to ensure processed materials are not classified as waste;
- Hydration of slag will require stockpiling of material on the medium term;
- Material containing asbestos would have to be used below a cover layer;
- Groundwater management and treatment may be required where excavation of saturated Made Ground is required;
- Excavation activities can lead to excessive noise, dust and odour generation without proper controls; and,
- Excavation below the groundwater table may not be feasible / cost effective.

7 ROA Conclusions

7.1 Environmental Remediation

The overall aim of the remediation and parallel enabling earthworks strategy is to prepare the site for a generic development, a key part of the enabling works will involve the turning over of Made Ground deposits and the removal of relic foundations and structures (Section 2.3) across the Site.

Arcadis have conducted a ROA to:

- Provide a robust environmental constraint management strategy for the Prairie Area, considering residual liabilities, reputational issues and statutory requirements, which evaluates the risks from the identified contamination and ground conditions at the site; and
- Evolve potential remediation strategies, minimising the environmental legacy of STDC and positioning the site footprint for redevelopment as a generic commercial / industrial end use, in a manner that will comply with applicable HSE, and waste regulations while minimising life-cycle costs to STDC.

As part of the ROA, Arcadis have summarised the current contaminant distribution, site conditions, hydrogeology, and active pollutant linkages based on the available data collected to date.

Based on a review of the results of the ranking process, site specific knowledge, consideration of the key remediation objectives, and view that the risk to human health receptors is the key driver for remediation at the site, Arcadis identified **capping *in situ*** as a preferred remediation strategy for the Human Health exceedances and asbestos identified at the site

7.2 Slags and Refractory Materials

Ground conditions at the site present a number of potential geotechnical constraints. It is anticipated that the majority of these can be dealt with by adopting appropriate engineering controls at the development phase.

However Arcadis recommend where potentially expansive slags and refractory materials are excavated as part of the enabling excavations these be managed by **Excavation, Separation, and Reuse** in low risk areas of the site as defined by STDC**. Treatment** may also be undertaken if this is identified as feasible for the materials in the given timescale.

The above is intended to reduce rather than eliminate the risks from these materials. Additional management through the use of **engineering controls** are likely to be required depending on the final redevelopment, these are to be the responsibility of the developer.

8 Enabling Earthworks and Remediation Strategy

The strategy for the enabling earthworks and remediation of the Phase 4 Prairie site should be considered within the wider context of the Redcar Steelworks reclamation and remediation. The excavated materials identified as not suitable for direct reuse will be consigned to a remedial process in order to meet the criteria for reuse after treatment. The exact technology is dependent on the volume and availability of the material and the timescale required to complete the remediation. The treatment of materials could be undertaken on the Prairie site as a single location or as part of a hub and cluster set up for the wider Redcar Steelworks site.

8.1 Aim

The aim of the works is to:

- Remove underground relic structures and foundations;
- Processing Made Ground materials in order to make suitable for use as backfill materials,
- Make the site suitable for future commercial / industrial end-use through SPR linkage breaks from materials impacted with asbestos, and,
- Reduce the geotechnical risks from slags and refractory materials removed as a consequence of the excavation works.

8.2 Overview of Required Works

In overview the enabling earthworks and remediation will comprise the following activities.

Enabling Earthworks

- Removal and processing of relic underground structures and foundations for reuse, to a depth of 2.5 m bgl. The requirement to remove areas of deeper structures or foundations, if encountered, will be assessed on a case by case basis.
- Screening and crushing of Made Ground materials in order to make suitable for reuse.
- Treatment of soils impacted with NAPL (if identified) in line with recommended processes identified within the ROA for Phases 1-3 of the Prairie site (10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy).
- Segregation of soils with ACM for treatment and reuse;
- Segregation and processing of refractory materials and potentially expansive slag deposits for reuse.
- Dewatering of below ground structures and excavations with management, treatment and disposal of water; and,
- Backfill of excavations to leave the site safe and level, with validated made ground, certified demolition arising, crushed concrete or imported fill.

Remediation

- Remediation of soils impacted with contaminants above target levels through capping of materials to manage SPR linkages.

8.3 Works Approach

8.3.1 Enabling works

Prior to mobilisation and commencing the enabling earthworks and remediation the following documentation, notifications, permits and approvals shall be obtained and in place:

- Approved Schedule;
- Construction Phase Health and Safety File;
- Method Statements and Risk Assessments;

- Occupational Health Plan;
- Environmental Permit;
- Temporary Trade Effluent Discharge Consent;
- Traffic Management Plan;
- Construction Environmental Management Plan;
- Materials Management Plan;
- Emergency Response Plan; and,
- Surface water management plan.

A site compound, including welfare facilities and parking will be required to be established in a suitable area on Site. Temporary buildings, structures, equipment and facilities shall be properly maintained for so long as it is in use, and the compound, welfare and parking facilities cleared away on completion. Appropriate site fencing, signage and security shall be implemented to protect the works.

8.3.2 Environmental Permit

An Environmental Permit (EP) Mobile Treatment Licence is likely to be required in order to conduct works comprising the treatment and reuse of site won material identified as requiring remediation and the treatment of any contaminated waters recovered during the works. This is typically held and deployed by the party responsible for designing and managing the execution of the remediation who are responsible and accountable for compliance with regulatory requirements. Such a permit is being applied for as part of the remediation works being conducted on Phases 1-3 under planning decision R/2020/0318/FFM.

To treat material from Phase 4 under the above permit a variation would need to be made and approved by the EA (Environmental Permit Team) detailing the remedial approach and associated engineering controls, prior to treatment being undertaken.

The excavation of site won materials which do not require treatment for environmental purposes does not need to be conducted under an EP. If uncontaminated made ground is to be processed and an EP for mobile plant is not in place then an EA Standard Rules Permit for the low risk crushing and screening of materials will be required.

8.3.3 Materials Management

Remediation measures will involve the movement of materials. It is important that they are not classified as a waste (as defined by Waste Framework Directive) on completion of the works.

8.3.3.1 Achieving Non-Waste Status

As discussed in Section 2.4, there are several different waste regulatory options available, the suitability of which is dependent upon the complexity of the site and the quantity/composition of the material to be reused. It has been concluded the most suitable option is via an application in accordance with CL:AIRE guidance ‘Definition of Waste: Development Industry Code of Practice’ (DoWCoP).

8.3.3.2 Definition of Waste: Development Industry Code of Practice

The Environment Agency (EA) has worked with industry through CL:AIRE to prepare the DoWCoP. The purpose of the DoWCoP is to allow industry to regulate itself with respect to determining whether excavated materials have achieved non-waste status. The EA states that ‘When a signed Declaration is sent to us (the EA) by a Qualified Person showing that excavated materials are to be dealt with as set out in the DoWCoP, we (the EA) will take the view that the materials on the site where they are to be used will not be waste.’

If materials are dealt within in accordance with the DoWCoP then the materials are unlikely to be waste. This is either due to the fact that the materials were never discarded in the first place or because they have been submitted to a recovery operation and have been completely recovered so that they have ceased to be waste.

In addition to the risk assessment, an MMP will be required detailing where soils were excavated from, where they will be moved to and how they will be tracked. Approvals will also need to be sought from the Local

Authority and the Environment Agency (groundwater team) with respect to the remediation strategy. Planning permission may also be required.

Once this documentation is in place a Qualified Person will review the overall strategy and ensure that everything is in place prior to submitting a formal declaration to the Environment Agency (waste team), via CL:AIRE (the scheme administrators). On completion of the work a verification report will need to be completed.

8.3.3.3 Materials Management Plan

An MMP shall be prepared in accordance with CL:AIRE Code of Practice (Definition of Waste) and authorised by a Qualified Person registered with CL:AIRE. Excavated materials will be segregated and sorted into categories as defined in Section 2.4.3.

8.3.4 Soil Sampling

Soil sampling will be undertaken by an STDC appointed representative and at the frequency proposed Sections 8.3.7 and 8.3.8.

Composite sampling from stockpiles will be undertaken in order to collect a representative sample. Stockpiles will be subdivided to representative sections, each section will be sub divided to 6 sub-sections, soils shall be collected from each subsection and homogenised in order to create the representative sample.

Further information on the proposed sampling strategy, including sampling frequency and testing schedule will be provided within the Enabling Earthworks and Remediation Implementation Plan and the Materials Management Plan.

8.3.5 Excavations

8.3.5.1 General Excavations

The scope of the excavation works is outlined in Section 2.3. Where practicable obstructions will be removed and crushed for re-use on site. Materials which are impacted with contaminants to levels above the defined reuse criteria shall be treated using the remediation strategy or if treatment is not considered possible disposed of offsite under full duty of care.

Made Ground materials will require size screening and crushing to enable reuse. Any deleterious materials not suitable for incorporation into the fill material, such as rebar, wood, plastic, putrescible materials etc will be segregated and stored separately on site. Such materials will then be disposed offsite under full duty of care.

8.3.5.2 Segregation and Stockpiling

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.

8.3.5.3 Surveying

All excavations shall be surveyed by the appointed Remediation Contractor to allow for accurate measurement of excavation extents and to establish remedial verification sample locations.

8.3.5.4 Relic Underground Structures and Services

The following shall be implemented with respect to relic structures:

- Relic structures shall be removed where encountered within the upper 2.5m of the Made Ground. Where relic structures are encountered within 2.5m bgl but continue below 2.5m bgl confirmation on the requirement to remove them below this depth shall be required from the STDC. If removal is not required a record of the residual foundation shall be made recording the topographical coordinates, size and type.
- Where encountered, piled foundations shall be removed to a maximum extent of 2.5m bgl. A record of the residual foundation shall be made recording the topographical coordinates, size and type.

- Redundant pipework is likely to be encountered within the excavations which may be preferential pathways for the migration of contamination. Where encountered redundant pipe work will be removed from the excavations and sealed at the edges of excavations.
- It is anticipated that at least one solidified metal mass is present on site resulting from the residual ore in torpedo ladle. Confirmation on the requirement to remove them shall be required from the STDC.

No specific development plans have been made available at the time of writing this remediation strategy and any future development plans may need to account for structures remaining in-*situ* or partially removed following these works depending on the specific redevelopment.

8.3.5.5 Boreholes

There are existing borehole installations across the site. Where possible boreholes within defined excavation areas should be protected, however if this is not practicable they are required to be decommissioned in accordance with the relevant British Standards and EA guidance.

8.3.5.6 UXO

A desktop UXO assessment has been completed for the STDC boundary. The outcome of the assessment indicates a Medium risk from 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). These additional mitigating factors should be defined within the Remediation Implementation Plan (RIP).

8.3.5.7 Utilities and Services

A review of the available data sources provided to Arcadis has highlighted a number of live services and utilities cross and bound the site. There is the potential for other utilities to be crossing the site including redundant gas pipes, water pipes and electrical cables as well as live 3rd party utilities.

At the time of writing a constraints plan is not available which would identify which site services and 3rd party utilities are required to remain and be protected during the remediation and reclamation works. The constraints plan would need to be reviewed and accounted for within the Remediation and Reclamation Implementation Plan.

8.3.6 Groundwater Management

Groundwater and accumulated water is anticipated to be encountered within excavations and subsurface structures, this will require removal to facilitate excavation and backfilling works.

The Contractor shall minimise the quantity of water requiring to be pumped, through backfilling excavations as soon as practicable and avoiding the potential for accumulation of rainwater in open excavations. Recovered groundwater will be sampled and classified to allow appropriate disposal, either via direct disposal to site foul drainage under discharge consent, *via* on site treatment and discharge to foul drainage under consent, or by tankerage and disposal from site. Any temporary storage of groundwater or accumulated water shall be within storage vessels, which are to bunded and equipped with drain-down and sampling valves.

8.3.6.1 Removal of NAPL on Groundwater

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.

8.3.7 Remediation Criteria

The following Remediation Criteria have been developed for Human Health receptors at the Site (in order of priority):

- LQM/CIEH Suitable for Use Levels (S4UL) (LQM / CIEH, 2015),
- Department of Environment Food and Rural Affairs (DEFRA) Category 4 Screening Levels (C4SL) (DEFRA, 2012),
- Arcadis derived generic assessment criteria based on CLEA v1.07,
- United States Environmental Protection Agency (U.S. EPA) Regional Screening Levels (RSLs)

Wood derived GAC for benzo(a)pyrene and naphthalene based on CLEA v1.07 were presented in their remedial strategy for the Prairie Phases 1-3 (41825-WOOD-XX-XX-RP-OC-0002_A_P012019). It is understood that these values and the use of the LQM S4Uls were acceptable to the regulator for this site and are therefore considered applicable for Phase 4.

Remediation Criteria for water resources will be defined following the completion of the DQRA.

Remediation Criteria Point	Remediation Objective	Compliance Criteria [1]
Excavation Extents	Ensure that concentrations of asbestos within soils within the uppermost 0.1m of materials do not have asbestos concentrations that exceed the defined risk-based thresholds	Composite soil samples do not exceed the Remediation Criteria. Samples collected at the following frequency • One sample per 25 linear metres of excavation from within the top 0.6m
	Ensure that soils remaining in-situ do not contain contaminant concentrations in excess of the remediation and reclamation criteria	Composite soil samples do not exceed the Remediation Criteria. Samples collected at the following frequency • One sample per 50 linear metres of excavation; and, • One sample per stratum or at 1.0m vertical intervals (whichever is the greater) • One sample per 2,500m^2 of excavation base
Imported Materials	Ensure that materials imported and used at the site do not introduce environmental or human health risks	Soil samples collected at a frequency of one sample per 1,000 m^3 of imported material (with a minimum of three samples per source) do not exceed the Remediation Criteria.
Accumulated NAPL	Ensure that no NAPL is present on groundwater as far as is reasonably practicable	No visible NAPL to be recorded on groundwater or accumulated water as far as reasonably practicable[2]

[1] Sampling frequency to be formalised and agreed as part of Remediation and Reclamation Implementation Plan and MMP

[2] To consider that further free phase recovery is not reasonably practicable, it should be demonstrated that free phase recovery rates have diminished to asymptotic conditions.

8.3.8 Suitability for Use Criteria

For excavated materials the following reuse criteria will apply:

Reuse Criteria Point	Objective	Compliance Criteria [3]
Reuse	To ensure that concentrations of contaminants within materials proposed for reuse do not exceed agreed reuse criteria.	Composite soil samples collected at a frequency of one sample per 500 m^3 of material proposed for re-use. Human Health - Laboratory analysis confirms concentrations of contaminants are below the criteria set out in Wood 2019 (LQM S4UL and Wood GAC). Water Resources – Reuse criteria to be confirmed by the DQRA Geotechnical – Backfill in line with Highways Specification. Exact specification to be confirmed in Earthworks Specification

8.3.8.1 Management of Contaminated Soils

In order to address the identified pollutant linkage in Section 2.2 it is proposed that remediation should be undertaken to break the pathway between the contaminants and the receptor (Section 6.2). This should comprise placement of protective cover layers in areas, where contaminants in soils are identified above the reuse criteria.

In order to facilitate development a temporary cover system should be installed across the footprint of the site, this temporary cover system should comprise 200mm of certified imported materials. The presence of the cover system should be considered when the final construction phase planning and design are finalised

As part of the future developer led re-development works, where hardstanding is not present and providing the required cover system, such as areas of soft standing, the following permanent cover system should be incorporated into the design and installed:

- Geotextile marker layer over soils containing exceedance of the reuse criteria; and
- 450-600 mm thickness of suitable imported materials.

If unexpected contamination of soils visibly impacted with NAPL or onsite screening / testing indicated the presence of NAPL they shall be consigned for treatment via one of the identified remediation approaches in order to make them suitable for re use in line with the Prairie Phase 1-3 strategy 10035117-AUK-XX-XX-RP-ZZ-0066-01-Prairie ROA and Strategy.

8.3.8.2 Management of Asbestos Containing Materials

Asbestos fibres have been identified in a number of locations across the site in made ground during the investigative works. No ACM hotspots have been identified, with fibre concentrations generally in the range of <0.001% to 0.034%. During excavation works to remove underground structures there is the potential for ACM to be encountered. 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 in excess of the reuse criteria will not be subject to mechanical screening where free fibres have been detected or are suspected. All soils containing asbestos will be managed by maintaining mist sprays to keep the soils wet whilst handled and covered when stockpiled.

[3] Sampling frequency to be formalised and agreed as part of Remediation and Reclamation Implementation Plan and MMP

Soils which have been identified as containing asbestos (or suspected to) will be stockpiled separately from all other excavated materials. These materials will be characterised by sampling and laboratory analysis.

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.

8.3.8.3 Management of Potential Expansive Slags and Refractory Materials

If these materials are excavated as part of the enabling earthworks they should be separated from other materials as far as practicable and stockpiled separately. Material should be crushed to 6f2 and reused in areas identified by STDC as low risk such as biodiversity enhancement areas.

8.3.9 Unexpected Contamination

Changes to the remediation strategy may be required during the remediation works, as a result of encountering unexpected contamination[4]. Should unexpected contamination be encountered, then further characterisation and risk assessment will be undertaken as required. An addendum to the strategy will be prepared detailing how this contamination will be dealt with. Written agreement with the regulators will be required prior to implementation of any amendments to the agreed strategy. Any such amendments shall be required to be fully documented within the Verification Report.

8.3.10 Verification of Excavations and Materials for Reuse

Materials identified for reuse will be required to be tested prior to placement to demonstrate compliance with the reuse criteria. Testing will be undertaken on a proposed frequency identified in Section 8.3.8.

8.3.11 Backfill

All Made Ground will be excavated and screened to remove oversize or deleterious material. Oversize material will be crushed for reuse, while deleterious material will be removed from site. All remaining material will be placed into stockpiles and subjected to testing and grading to ensure suitability as defined in series 600 of the Specification for Highways. Where the material does not meet the suitability criteria, it will be subjected to physical treatment, modification or stabilisation as required to achieve the necessary degree of compaction.

No detailed redevelopment design is currently available for the site and therefore no groundworks model with cut and fill levels is available. In addition, the geotechnical specification for backfilling is not provided as a development ready platform but to provide a level access to and around the site.

At the time of writing the Earthworks Specification is yet to be completed. Following the completion of the Earthworks Specification, the excavation, processing and backfilling specifications of this document will be required to be updated to reflect the changes.

Where required imported materials shall be used to fulfil any materials deficit. Imported material must be certified free of asbestos and other deleterious material. For each source of imported material for backfill, a material statement shall be provided detailing the chemical testing results, geotechnical testing material classification, destination of material deposition on site and proposed method of compaction. Site won materials that are re-used on site must be demonstrated as suitable for use in accordance with the MMP. Prior to backfill, excavations will be dewatered. Excavations will be backfilled in layers in accordance with the Highway Specifications.

8.3.12 Environmental Controls and Management

A Construction Phase Environmental Management Plan (CPEMP) should be prepared for the Works and shall consider the following environmental aspects.

[4] This is defined as any contamination source which is distinct in its chemical or physical composition from the type of source material considered within the conceptual site model.

8.3.12.1 Surface Water Management

A surface water management plan shall be developed and implemented as a component of the CPEMP to provide temporary drainage facilities and protection measures (such as silt fences) as necessary to ensure the site, the Remediation Works, the adjacent land and existing facilities are adequately drained, and run-off managed during the course of the Work.

Surface water and other water generated as part of the Works shall be monitored and treated via a drainage silt trap / settlement tank, or similar, to remove solids and fines from water. Any further treatment necessary to effect compliance with the consent limits shall be designed, installed and maintained.

8.3.12.2 Dust, Noise and Vibration

Air Quality and Dust Management Plan

An Air Quality and Dust Management Plan will be prepared as a component of the CPEMP. Baseline data will be collected as part of this plan to allow the impact of the works on the surrounding environment to be determined and allow the success of control measures undertaken to protect the site workforce and neighbouring receptors to be assessed. Trigger levels for remedial action will be defined within this plan.

Dust control measures will be implemented through the works including the use of damping down, sealing of stockpiles and vehicle wash facilities to prevent the transport of mud and debris from the site onto public roads.

Noise

Prior to commencement on site noise data will be taken to establish baseline conditions. Trigger levels to prevent unacceptable impacts to receptors shall be identified within the CPEMP and agreed with the Regulators. Noise monitoring stations will be implemented to monitor the impact of the Works against background levels and allow measures to be implemented to ensure noise levels remain below these limits.

Vibration

Prior to commencement on site vibration levels will be taken to establish baseline conditions. Trigger levels to prevent unacceptable impacts to receptors shall be identified within the CPEMP and agreed with the regulators. The Contractor shall implement vibration monitoring stations to monitor the impact of the Works against background level and these limits.

8.3.12.3 Ecology/Invasive Species

The site is approximately 1.5km south of the Teesmouth and Cleveland Coast SPA, Ramsar and SSSI site. At the time of writing this report it is not known if the site is currently being used by designated bird species from the Teesmouth and Cleveland Coast SPA.

Ecological surveys and habitat risk assessments should be completed to identify control measures and mitigation identified within shall be adopted in relations to the remediation and restorations works and future development.

8.3.13 Surface Water Features

Should the redevelopment require the realignment of Knitting Wife Beck or the Cross Connector the engineering design for the new route will need to consider the condition of soil and or groundwater in the area of the proposed diversion and determine if measures to break the potential pathway between ground and surface water are required within the design.

8.3.14 Surface Water Management

During groundworks the Contractor shall take measures to prevent surface water and sediment run off from the excavation and treatment areas and prevent its entry into surface water features.

9 Reporting

9.1 Pre-commencement

9.1.1 Enabling Earthworks Remediation Implementation Plan

The specific objective of the Enabling Earthworks and Remediation Implementation Plan (EERIP) is to produce a site-specific plan detailing the design and methodology of the selected remediation approach to be applied at the site. This will incorporate remediation programme and the monitoring and validation requirements.

The EERIP will be undertaken in accordance with the requirements of LCRM guidance and will include the following tasks:

- Review of the site characteristics – in particular any variation from currently known conditions;
- Development of remediation technical specification;
- Development of implementation methodology;
- Discussion of any additional regulatory requirement; and,
- Details on methodology for verification of remedial works.

9.1.2 Materials Management Plans

An MMP shall be prepared by the appointed Contractor in accordance with CL:AIRE DoWCoP and authorised by a Qualified Person registered with CL:AIRE.

9.1.3 Construction Phase Environmental Management Plan

The appointed Contractor will prepare a CPEMP for the works. This will consider the potential impacts that the works will have on the environment and include any monitoring and control measures required.

The plan will set out the monitoring and recording process for the management and minimisation of waste, including the storage and transport of waste on-site. This will include a recording mechanism for required waste documentation such as Waste Transfer or Consignment Notes (dependent on the waste stream) in order to confirm the assessment of the waste impact and to implement embedded mitigation measures.

The CPEMP will include their methodologies for controlling and monitoring the following aspects of the works:

- Waste Management Procedures
- Noise and vibration
- Air quality and dust management
- Any ecological mitigations required
- Surface water drainage
- Spills and environmental releases
- Monitoring and measuring procedures
- Relevant policies, legal requirements and key stakeholders

9.2 Implementation

During remediation implementation, regular meetings will be held and minuted by the remediation contractor to provide robust control of the work. Meetings are proposed to include:

- Pre-start Meeting
- Daily Site Briefings
- Weekly Site Progress Meetings
- Fortnightly Contract Review meetings

- Risk Reduction/Change Management Meetings
- Project Close Out Meeting

Data types to be collected and reviewed during the remediation implementation period are described in Section 9.3 below. Records will be produced to detail progress of the works. Should site conditions vary from those currently known, resulting in a change to the proposed remediation strategy, this will be communicated to relevant stakeholders at the earliest opportunity to allow for an amended approach to be developed and approved.

9.3 Remediation Works Verification Report

Verification of remediation will be based on a number of lines of evidence collected during the works and tracked through the implementation phase. These will be documented within the final Verification Report as follows:

9.3.1 Field records

Field records to verify the works may include the following

- Excavation extents and depths supported by topographic survey data;
- Field screening / onsite analysis of soil samples;
- Volumetric records of water and free phase hydrocarbons recovered from excavations; and,
- Photographic records.

9.3.2 Laboratory Results

Soil and water sampling and accredited laboratory analysis data will be provided to confirm that:

- On completion of excavations contaminant concentrations within remaining in situ soil meets the reuse criteria, as far as is reasonably practicable (laboratory results).
- Contaminant concentrations within excavated soil that may be re-used onsite as infill to excavations, meet the reuse criteria.
- Laboratory analysis of recovered groundwater / treated groundwater to support off-site disposal, re-infiltration or disposal under consent to foul drainage network.
- Laboratory analysis results of material imported onto site as backfill will be obtained to demonstrate material meets the reuse criteria.

Geotechnical testing of reinstated material to ensure compliance with Earthworks Specification. Laboratory analysis will be undertaken by a UKAS accredited laboratory.

9.3.3 Topographic Survey Records and Drawings

Site drawings and topographic plans will be developed to demonstrate that:

- Source areas have been removed (if identified) and provide records of excavation extents during the Works;
- Records of below ground obstructions left in-situ following the works
- Site levels have been restored to the agreed formation levels;
- Thickness and extent of capping layer placed on the site; and,
- Re-used materials have been located in the correct place through as-built drawings showing locations of remedial works and records of residual hazards

9.3.4 Materials Audit Trail Records & Environmental Monitoring

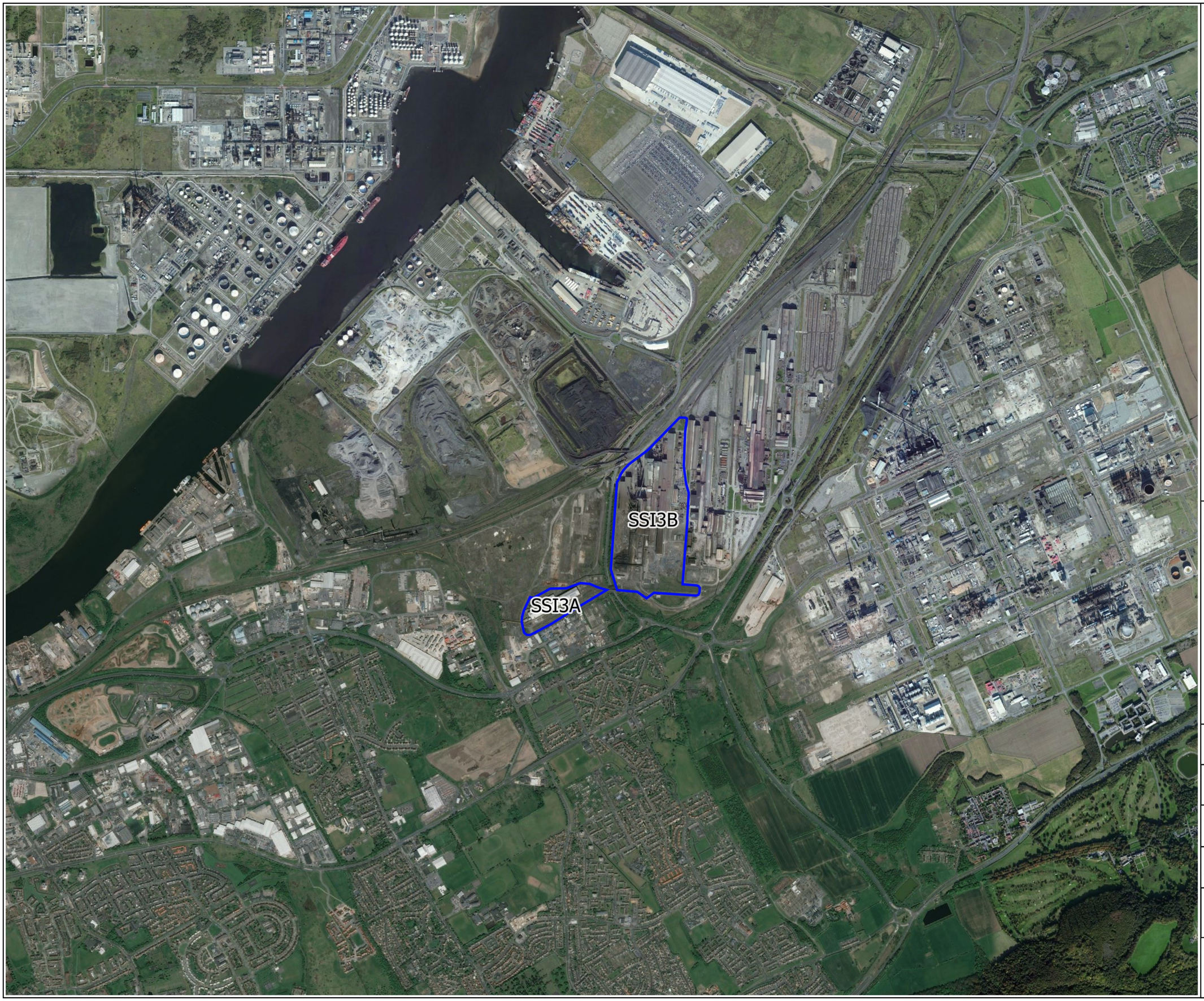
The results of the monitoring and testing set out in the CPEMP, including details of any spills or emergency response measures employed, will be included together with evidence to demonstrate that:

- Re-used material has been deposited in the correct location in compliance with the materials management plan;
- Waste materials have been properly quantified and have been accepted by an appropriately licenced facility include completed waste transfer documentation; and that

Imported materials are of correct quality and volume for use on site and free of asbestos..

APPENDIX A

Figures



Legend

Contract 3

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

N

Title:
SSI3 Site Location Plan

Site:
Redcar Steelworks

Client:
South Tees Site Company

Project: 37774100	**Figure 1**

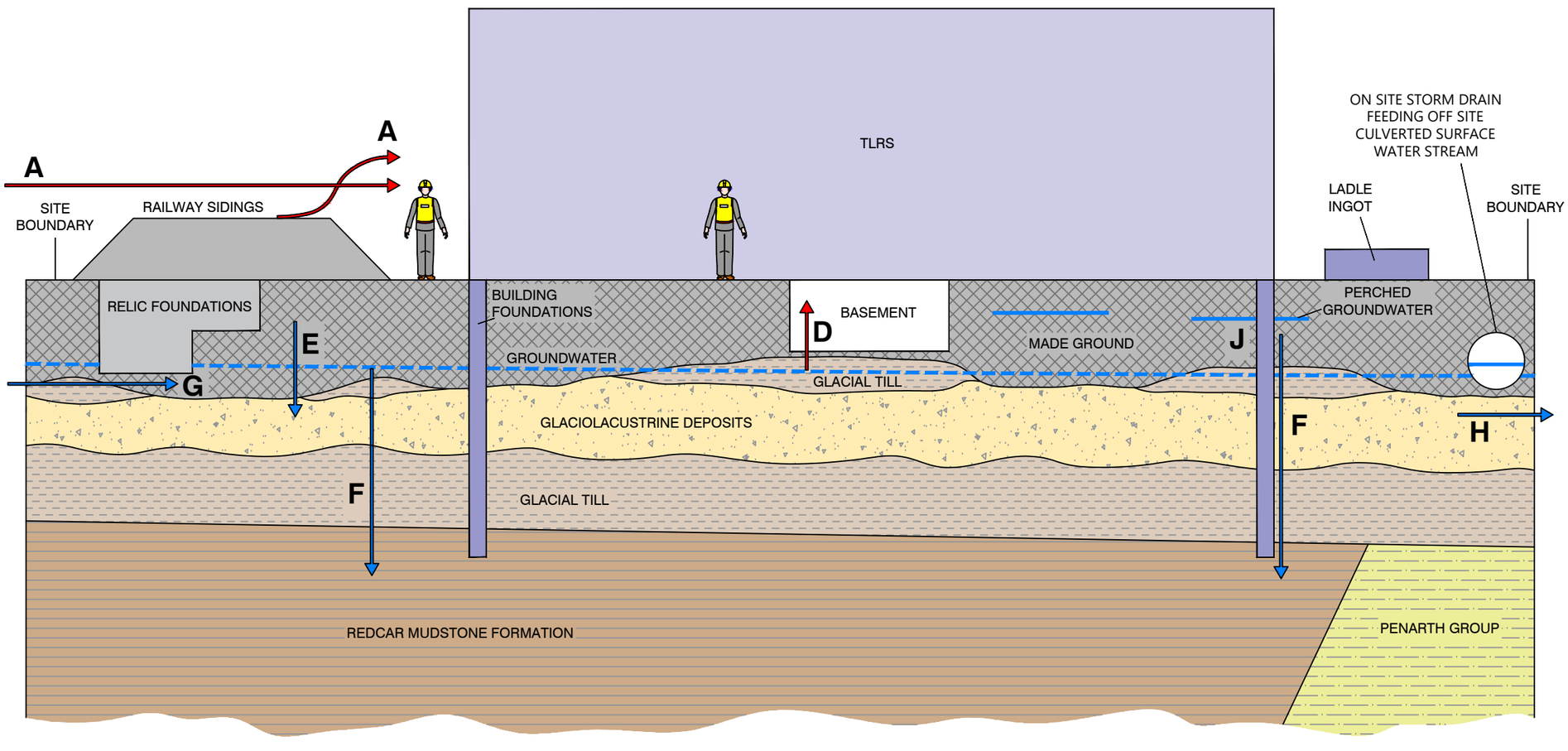
Date: 24/04/2018
Drawn By: JALM
DRG No: 37774100_01_SSI2b_Figure_1

ARCADIS Design & Consultancy for natural and built assets

Potential Human Health SPR Linkages
A = Dust inhalation from Made Ground from site and adjacent land
D = Accumulation of ground gas in confined spaces
SPR linkages for construction workers during redevelopment not shown

Potential Water Resource SPR Linkages
E = Leaching of contaminants from Made Ground and point sources to groundwater in superficial deposits
F = Migration of contaminated groundwater to (Secondary (Undifferentiated) Aquifer) in bedrock
G = Migration of contaminated groundwater onto site in Made Ground and Superficial Deposits
H = Migration of contaminated groundwater off site in Made Ground and Superficial Deposits

Other SRP Linkages
J = Attack by contaminants of concern on foundations



KEY

NOTES

SCHEMATIC DRAWING ONLY - NOT TO SCALE

REV	DATE	COMMENT	CAD

TITLE: UPDATED CONCEPTUAL SITE MODEL - SSI3 AREA A TLRS

SITE: REDCAR

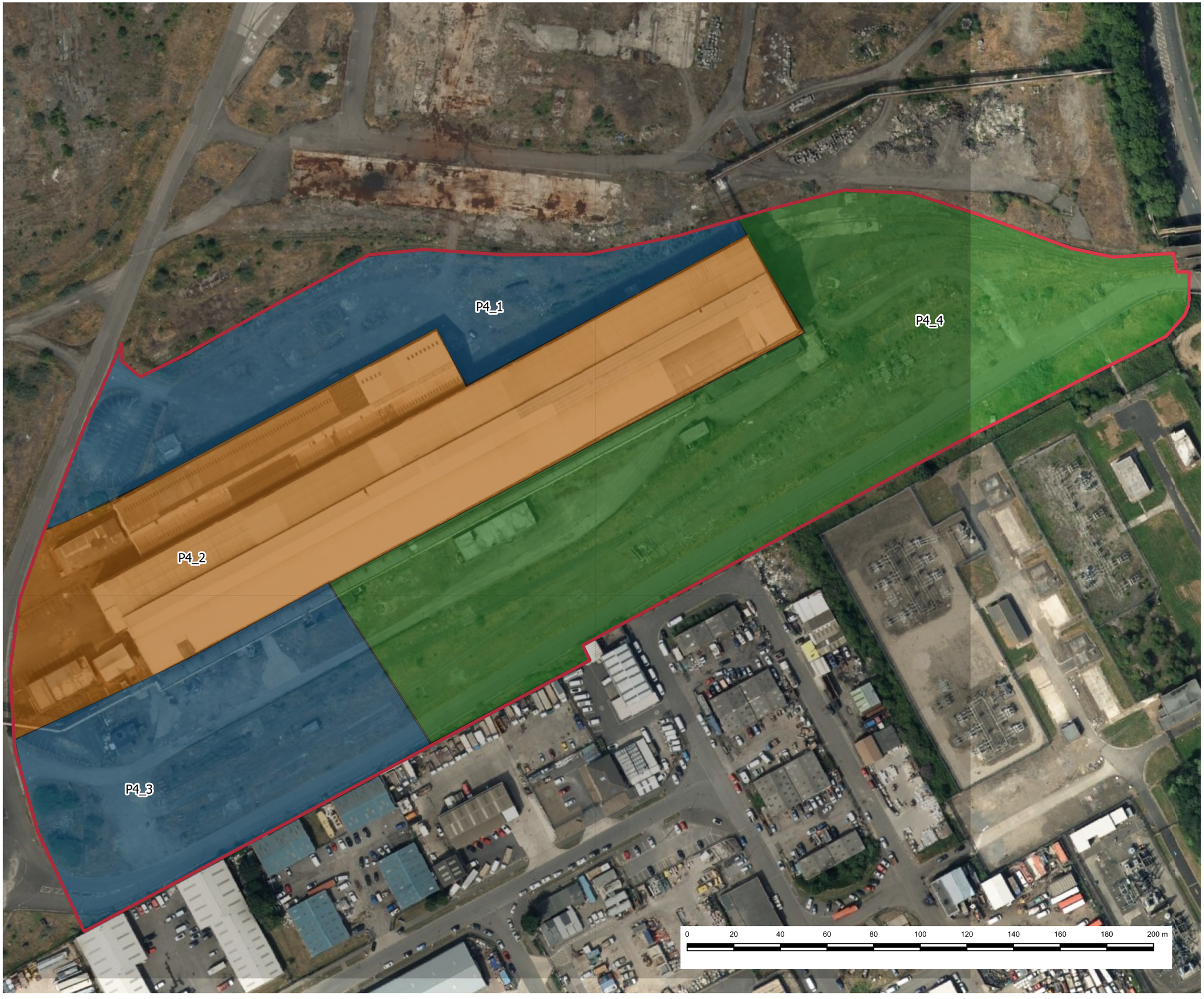
CLIENT: STSC

PROJECT: 10013655 | FIGURE 2A

DATE: 02/07/18 | DRAWN: BNB | REV: -

DRG.No.: 10013655_CSM_1 | PRINT: A3

ARCADIS Design & Consultancy for natural and built assets



Legend

Maximum Dig Depths

Remedial Excavations (mbgl)

- 2.5
- 3.5
- 4

Plans

Redline

- SSI3A

Maps

Bing

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

N

Title:
Prairie Phase 4 - Maximum Dig Depths

Site:
Redcar Steelworks - Prairie Phase 4

Client:
South Tees Developement Corporation

Project:
10035117

Figure 3

Date: 04/02/2021
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0264-01-Prairie_Phase4_Dig_Plan

ARCADIS Design & Consultancy for natural and built assets

Legend

Asbestos Plots

- Asbestos Detected (%)
- No Asbestos Detected

Site Areas

- Contract 3

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

Format: LocationID_Result_% composition

N

Title:
SSI3A Summary of Asbestos Testing

Site:
Redcar Steelworks

Client:
South Tees Site Company

Project:
37774100

SSI3A Figure 4

Date: 20/04/2018
Drawn By: JALM
DRG No:

ARCADIS Design & Consultancy for natural and built assets

APPENDIX B

Study Limitations

IMPORTANT: This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1. This report has been prepared by Arcadis UK Ltd (Arcadis), with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with **STDC** (the 'Client'). Arcadis does not accept responsibility for any matters outside the agreed scope.

2. This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.

3. Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. Arcadis are unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have unpublished, more stringent objectives. Further work may be required by these parties.

4. All work carried out in preparing this report has used, and is based on, Arcadis' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice, pending changes in legislation, of which Arcadis is aware, have been considered. Following delivery of the report, Arcadis have no obligation to advise the Client or any other party of such changes or their repercussions.

5. This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6. Whilst this report and the opinions made are correct to the best of Arcadis' belief, Arcadis cannot guarantee the accuracy or completeness of any information provided by third parties.

7. This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have been received.

8. This report refers, within the limitations stated, to the condition of the Site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the Site since the time of the investigation.

9. The content of this report represents the professional opinion of experienced environmental consultants. Arcadis does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10. Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.

11. If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on Site.

12. Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issue

APPENDIX C

Remediation Option Appraisal Tables

SUMMARY OF SOIL TREATMENT TECHNOLOGIES: Technical Parameters

	SSI3 Area A (TLRS)			
	Hand Picking	**Excavation and Disposal**	**Capping in situ**	
Technical Parameters				
Contaminant Properties	0	3	3	0 -Technology not suitable 1- Technology may work (50%) 2 -Technology will probably work (70%) 3- Technology very suitable (90% +)
Geology / Hydrogeology Suitable	2	3	3	0 -Technology not suitable 1- Technology may work (50%) 2 -Technology will probably work (70%) 3- Technology very suitable (90% +)
Extent of Contamination	0	3	3	0 -Technology not suitable 1- Technology may work (50%) 2 -Technology will probably work (70%) 3- Technology very suitable (90% +)
Technical Score	**2**	**9**	**9**	
Technical Ranking	**3**	**1**	**1**	

SUMMARY OF SOIL TREATMENT TECHNOLOGIES: Operational and Commercial Parameters

	Hand Picking	**Excavation and Disposal**	**Capping in situ**	
Operational Parameters				
Operational Implementation		1	2	0 -Impact on future site operation not acceptable 1 -High impact on future site operation 2 -Minor impact on future site operation 3 -Minimal impact on future site operation
Operational Requirements		1	2	1 -Substantial operational requirement (e.g. power and large plant required) 2 -Relatively large operational requirements (e.g. power and portable plant) 3 -Very Minor Operational Requirement (e.g. Monitoring Only)
Permissions / Permits		3	3	1 -Permits difficult to obtain 2 -Permits will need applying for 3 - Permits held in UK by many suppliers
Track Record / Development Status		3	3	1 -Remedial approach has not been applied at full scale in U.K. 2 -Remedial approach has limited application at full scale in U.K. 3- Remedial approach has been used extensively at full scale in U.K.
Operational Score		**8**	**10**	
Operational Ranking		**2**	**1**	
Commercial Parameters				
Residual Liability		2	1	1 -Contaminated material left in place. Pathway or receptor addressed 2 -Contaminants treated or removed from site 3 -Contaminants destroyed
Commercial Availability		3	3	1 -Equipment not readily available in UK 2 -Equipment available in UK 3- Equipment readily available in the UK
Remediation Timescale		3	3	1 -Slow > 5years 2 -Moderate 2-5 years 3 -Fast <2 years
Capital Cost		1	3	1 High 2 Medium 3 Low
O&M Cost		3	3	1 High 2 Medium 3 Low
Commercial Score		**12**	**13**	
Commercial Ranking		**2**	**1**	
Cumulative Score		**29**	**32**	
Final Ranking		**2**	**1**	

Notes

Remediation Technology no longer considered based on score from Technical Parameters

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