GRANGETOWN PRAIRIE AREA, FORMER STEELWORKS, REDCAR

Phase II Environmental Site Assessment

South Tees Development Corporation

REPORT NO. 10035117-AUK-XX-XX-RP-ZZ-0062-02-Prairie_ESA

NOVEMBER 2020

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Grangetown Prairie Area, Former Steelworks Redcar, Environmental Site Assessment

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1 Introduction

1.1 Project Background

The Grangetown Prairie (Prairie) Area (the site) is a land parcel situated at the Former Redcar Steelworks located within the Redcar, Lackenby, Grangetown and South Bank conurbations of the Borough of Redcar & Cleveland, within the industrial area generally known as 'South Tees'. The site location is shown on Figure 1 in Appendix A.

The South Tees Regeneration Masterplan has been developed detailing the industrial-led regeneration of the Former Redcar Steelworks into a world class employment-generating zone and economic growth enabler for the Tees Valley.

The Masterplan has identified the Prairie Area (also known as Cleveland South) as being located within the Southern Industrial Zone. The site is a priority development area and Arcadis understands this report is to be used within a detailed planning application scheduled for submission in June 2020.

1.2 Contract Details

Arcadis (UK) Limited (Arcadis) was appointed by South Tees Development Corporation (STDC) to oversee and manage a ground investigation undertaken by Allied Exploration and Geotechnics Limited (AEG) and to provide consultancy advice on the redevelopment of the site.

The work was carried out in accordance with the "*Prairie Site, Warrenby Site and the SLEMS Ground Investigations Provision of Consultancy Services* Agreement between Tees Valley Combined Authority and Arcadis.

The scope of works was defined by Arcadis, on behalf of STDC, as presented in:

- STDC-SS-0028 – GI Consultancy - Prairie, sent 17th May 2018; and,
- Email "Prairie – Geo-Environmental Consultancy Support" correspondence from Arcadis to STDC 9th August 2019

1.3 Projects Aims and Objectives

The overarching aim of the project is to deliver a sustainable ground remediation strategy for the contract site which is compliant with regulatory needs and has their approval in principle.

As technical consultant, our specific objectives are to:

- Manage and technically supervise the site works, undertaken by AEG, on behalf of STDC;
- Direct the site works to ensure compliance by the ground investigation contractors with existing site management protocols and procedures;
- Specify the requirements for laboratory analysis;
- Analyse the results of ground investigations;
- Prepare an interpretative technical report including an assessment of identified environmental risks associated with the site (*this document*),
- Consult with regulators to ensure compliance with all relevant regulatory requirements; and,
- Input into the development of a cost-effective, value-engineered remediation strategy for the site (reported under a different cover).

1.4 Report Aims

The aim of this environmental site assessment report is to use the available information to develop a conceptual site model (CSM) for the site and identify the significance of any source-pathway-receptor (SPR) linkages identified by the CSM for the contract area. Where significant, and potentially complete, pollutant linkages are identified, suitable risk management/remediation recommendations are to be made. As such, within this report Arcadis has provided an overview of the findings of the AEG site investigation and used the

information to prepare this interpretative technical report. The findings from this report are supporting the development of a cost-effective, value-engineered remediation strategy for the site.

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 Site Conceptualisation

No specific Phase I Environmental Site Assessment (ESA) exists for the site however the area is covered by the following document supplied by STDC:

- TS3 Grangetown Prairie – Phase 1 Geo-Environmental Desk Study, prepared by CH2M Hill for the Homes and Communities Agency, report ref. 678079_TS3_001 dated August 2017 and marked Final [CH2M2017].

In addition, STDC also supplied the following documents:

- 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 dated25th June 2019 [Wood 2019]
- Prairie Site, Off Clay lane – Ground Investigation Factual Report, Prepared for One North East by Shadbolt Environmental dated July 2011.
- Former Corus Cleveland Prairie Site: Land off Clay Lane – Ground Investigation Interpretative Report, prepared by MD2 for One North East, Ref MD2_113 dated 25th July 2011
- Phase II Geo-environmental Assessment at Corus Cleveland Prairie Teesside Site, prepared by Enviros Consulting Ltd. for Graphite Resources, Ref. GR1280001 dated March 2008
- Corus Cleveland Prairie Teesside Site Phase I Environmental Review, prepared by Enviros Consulting Ltd. for Graphite Resources, Ref. GR1280001 dated August 2007
- 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

This section incorporates a review of the above reports, publicly available records, and data collected as part of the site investigation works by AEG 4251 - Prairie Site Ground Investigation Works (Final Report r01) presented as Appendix C.

The scope completed by AEG is summarised below:

- 110no. trial pits excavated by a 20 tonne 360 excavator, to a target depth of 4.5m or refusal, or until natural material was encountered;
- 10no. boreholes drilled by a Dando 2000 cable-percussive rig, with target depths of between 10m and 20m, or refusal on bedrock, 4no. of these boreholes were advanced 5m into the underlying bedrock. Boreholes were advanced through previously excavated trial pits;
- Soil sampling for in-field assessment and submission to Derwentside Environmental Testing Services (DETS), AEG in-house Geotechnical Laboratory and Thomas Research Services (TRS) laboratories for chemical and geotechnical testing;
- Installation of 12no. groundwater monitoring wells (including 2no. twin installations) with subsequent purge development;
- Groundwater sampling of all newly installed monitoring wells;
- Groundwater elevation survey of all newly installed monitoring wells.

2.1 Site Location

The Prairie Area is located in the south west of the former Redcar Steelworks, between the Darlington to Saltburn Railway, Tees Dock Road, Eston Road, and DTDC's SSI3A/ TLRS land holding. The site elevation generally ranges from approximately 5m to 15m above Ordnance Datum (AOD).

The centre of site is located at approximately National Grid Reference: 454675, 521389 and an indicative post code for the site is TS10 5QW.

A Site Location Plan is presented on Figure 1 within Appendix A.

2.2 Site Description

The site is approximately 54 hectares in size and irregular in shape. The bulk of the site is approximately trapezoidal in shape with the northern boundary being the longer edge. Additional narrow spurs are present from the south west and north east corners. The Darlington to Saltburn Railway is located along the northern boundary of the site and the SSI3A/TLRS landholding forms the bulk of the southern boundary.

With the exception of a small relic Oxygen Plant and a former Loco Repair Shop, the site has been demolished to slab level with concrete foundations, roadways and crushed aggregate including steelmaking wastes forming the bulk of the site surfacing, which is covered by scrub in places. The site is broadly level with the exception of isolated bunds and mounds (particularly associated with the former blast furnaces, where a large metal rich boulder is present and the coke ovens) and two prominent features, namely:

- A large embankment running north-south in the south west of the site which reaches a height of approximately 15m above the surrounding land. This embankment formerly carried railway tracks to blast furnaces. The remaining structures (Oxygen Plant and Loco Repair Shop) are sited at the base of the embankment; and,
- A depression running north south adjacent to the main western boundary where the topography dips down to an underpass beneath the railway.

Two surface water features are culverted beneath the site; Holme Beck in the west and the Knitting Wife Beck in the east. A number of utilities are present on site including the Redcar Steelworks Coke Oven Gas (COG) main which crosses the site above ground from south east to north west. The GOC main is currently in the process of being decommissioned but at the time of writing is still considered a top tier COMAH asset. Overhead pylons run along the northern and eastern edge of the site and a Northumbrian Water Sewer runs along the northern edge of the site.

The site setting and layout are shown on Figure 2 and in Appendix A.

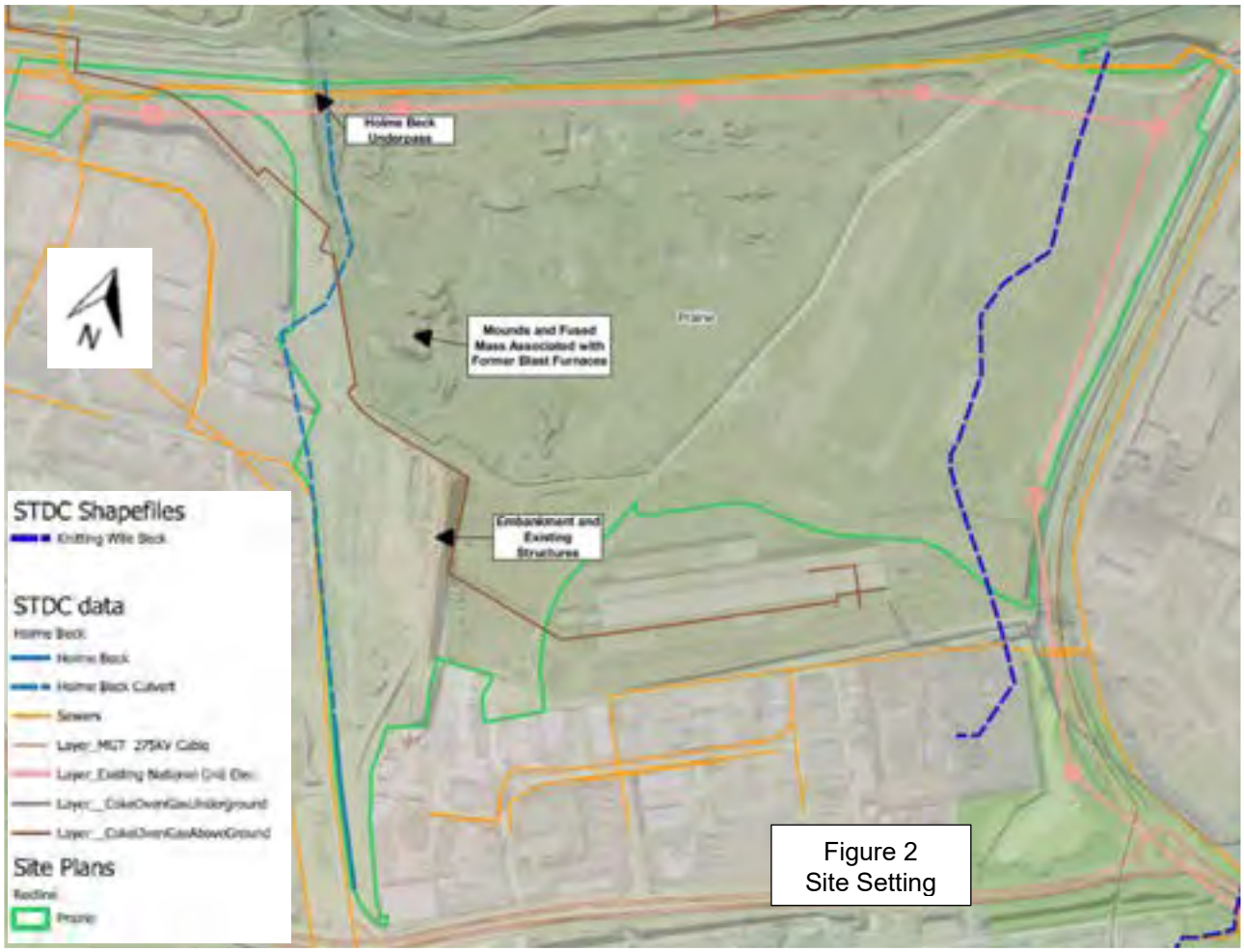

Figure 2
Site Setting

2.3 Site History

A full site history is given in Wood (2019) and CH2M (2017). In summary:

- In 1857 the site was predominantly agricultural land. Railways ran along the northern boundary of the site (in the location of the current Darlington to Saltburn line) and also down the western edge of the site within the current site boundary. A small iron works (Eston Iron Works) is shown in the north west of the site. The Tees Estuary was located to the north of the site beyond the railway.
- Mapping from 1893 shows the Cleveland Steel Works to occupy the western half of the site; the Cleveland Iron Works extends onto the far western areas of the site. Small water bodies are shown on the site. By 1913 the steelworks has expanded further into the eastern half of the site and the water bodies are no longer shown. Estuary reclamation is shown to the north of the site.

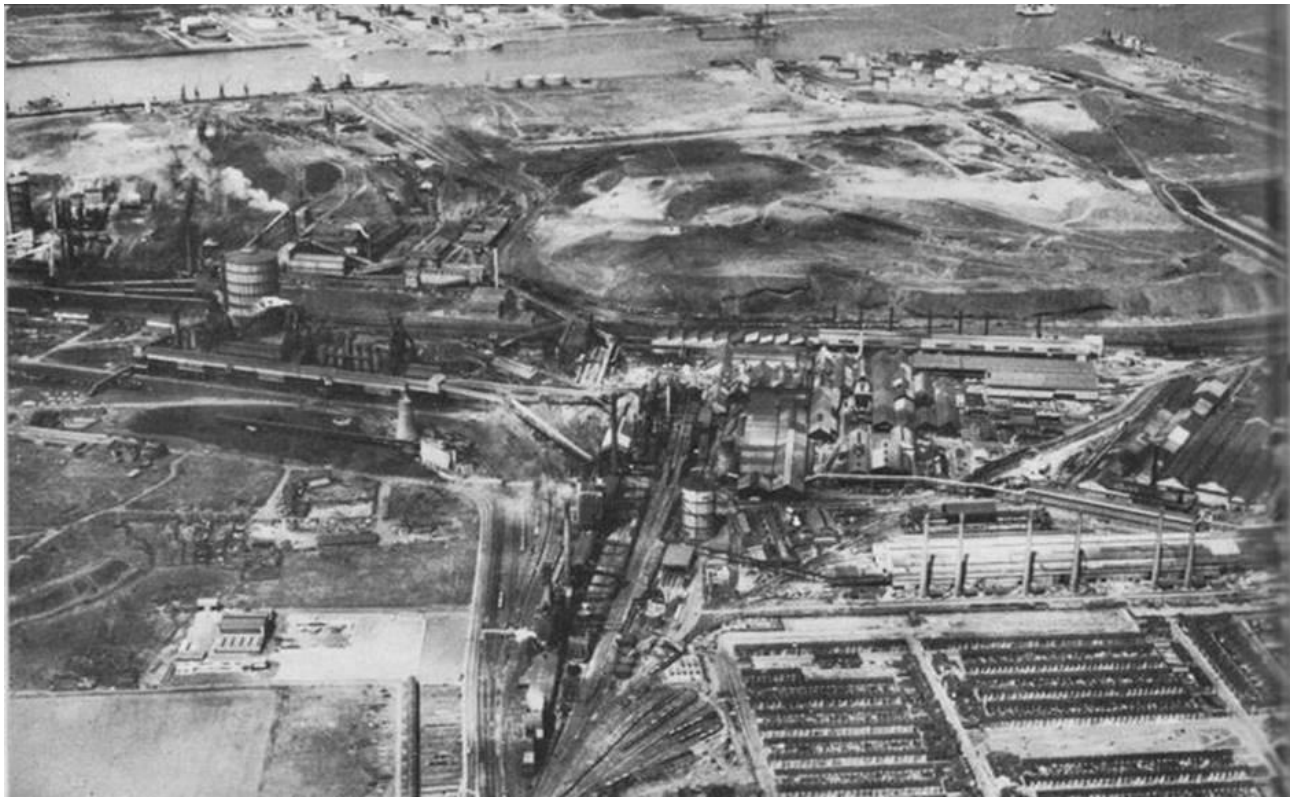

Plate 1 – Site circa 1924

- From 1924 further development has occurred on the eastern half of the site with additional large structures shown. A structure is shown to the south of the site in the location and with the approximate outline of the current TLRS (understood at this time to be the South Steel Plant). Plate 1 provided by STDC is understood to show the site in 1924.
- By 1952 the Cleveland Coke Ovens and biproducts plant have been constructed in the south west of the site. In the east of the site further expansion of structures has taken place, the largest of these is understood to have been known as the Colliery Arch Plant and Medium Section Mill (information provided by STDC, drawing 1x5971). The site layout at circa. 1960 is shown on drawing 1x5947 (Figure 3).

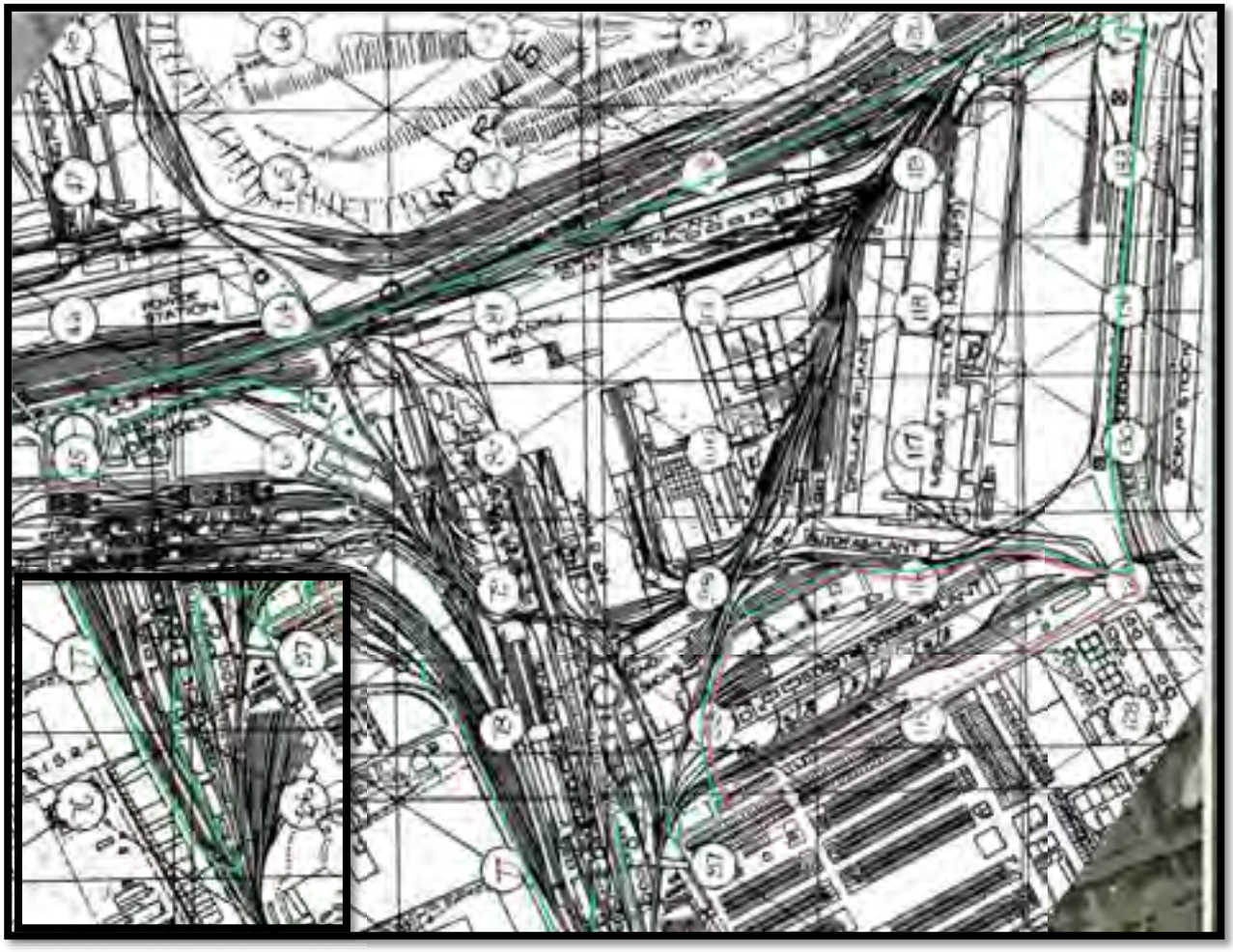

Figure 3 – Site layout circa 1960

- Mapping from the 1970's to the 1990's indicates progressive demolition of the majority of structures on the western half of the site. Based on information provided by STDC the bulk of the facilities on site became obsolete after the construction of the BOS and CONCAST plants in the 1970's. The Colliery Arch plant is shown on mapping until 2010 after which it no longer appears. The site was used as a steel stocking yard following structure demolition. Plate 2 provided by STDC shows the Colliery Arch Plant prior to demolition in 2010; the large structure in the mid ground is the former Power Station (now also demolished), with the South Bank Coke Ovens off site in the background.

Plate 2 – Site Circa 2010

2.4 Geology

Historical borehole logs from Enviros and others indicate a substantial thickness of Made Ground underlies much of the site. Review of the British Geological Survey (BGS) data also suggests the presence of Made Ground at the site (in the east and south); 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.

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:

- **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;
- **Penarth Group** (approximately 15m in thickness) comprising grey to black mudstones with subordinate limestones and sandstones;
- **Mercia Mudstone Group** (approximately 200m in thickness) comprising predominantly red mudstones and subordinate siltstones with thick halite-bearing units.

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

Exerts from the BGS mapping data are presented as Figure 4 and in Appendix A.

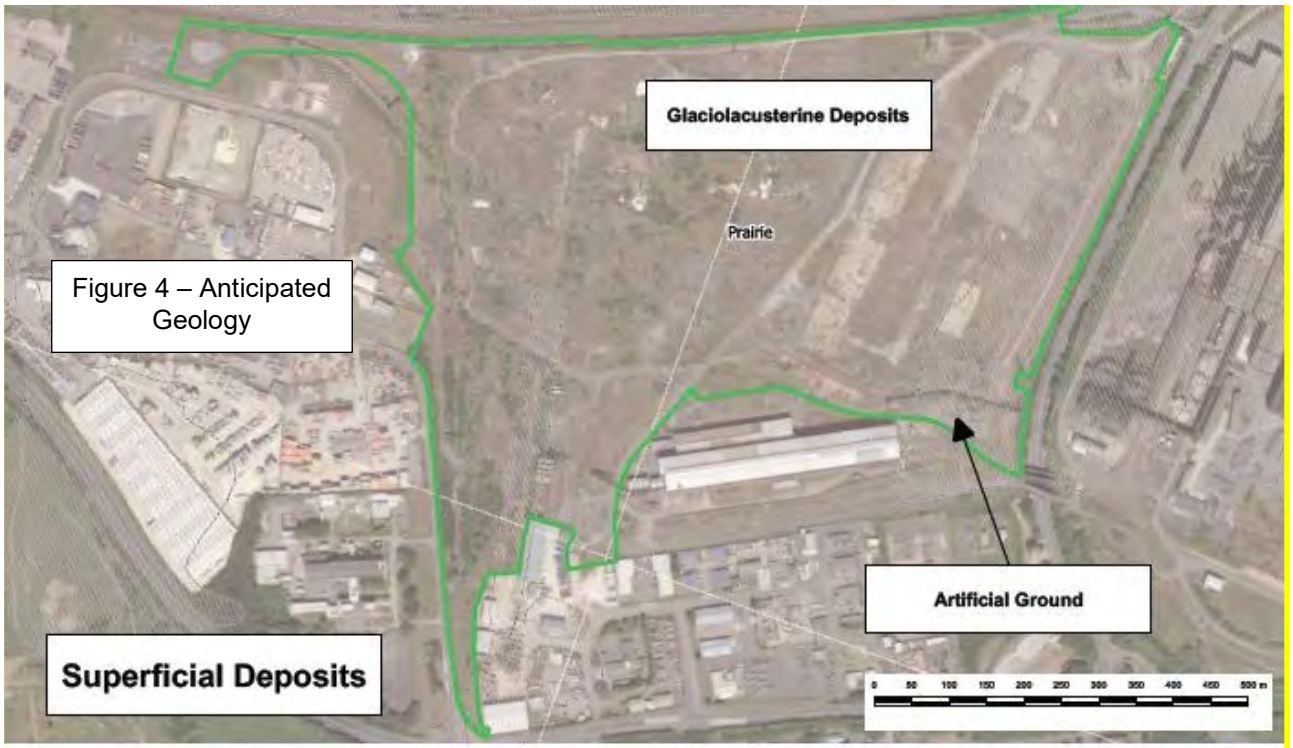

Figure 4 – Anticipated Geology

The following table provides an overview of the site-specific geology encountered during the investigation across the site. The full geology encountered is provided on the AEG trial pit and borehole logs within Appendix C, a borehole and trial pit location plan is provided with the logs.

Unit	Minimum Basal Depth (m bgl)	Maximum Basal Depth (m bgl)	Comment
Made Ground	0.60	5.00 (8.00)	Site surfacing comprised either soft standing of gravels, slag, brick paviour, concrete, or bituminous surfacing. The Made Ground encountered during the investigation predominantly comprised granular material with a fine-grained component and medium to high cobble/boulder content which included slag, brick, concrete and occasionally clinker, coke, coal and/or metal. Rare to frequent refractory materials were identified in a number of trial pits across the site. Based on visual assessment slag was found to be the dominant component of Made Ground in 24 of 122 trial pits. Frequent relic foundations and structures were identified particularly in the west of the site. In one location made ground was identified to a depth of 8m bgl (Prairie_BH102), however this was atypical of the surrounding area and it could not be confirmed if this represented true ground conditions or an obstruction being driven into the underlying superficial deposits.
Tidal Flat Deposits (Secondary A Aquifer)	0.4	4.5	Encountered in 41 trial pits and 1 boreholes. Generally comprised soft to firm sandy silty clays or sandy clayey silts with varying amounts of plant remains. Identified to be widely distributed across the site below the Made Ground. Were the full thickness of the Tidal Flat Deposits was proven this was found to be limited and generally less than 1.5m. Tidal Flat Deposits were not identified in 22 locations where natural deposits were proven. The majority of these were located in the west of the site.
Glaciolacustrine Deposits (non-Aquifer)	0.8	10.6	Although indicated as present on the geological maps of the area Glaciolacustrine Deposits were only recorded 29 of the trial pits and 8 boreholes. Where identified, the Glaciolacustrine Deposits were generally noted to be below Tidal Flat Deposits, although in five locations the Tidal Flat Deposits were absent. This finding is in line with the previous environmental investigation of the Cleveland Works conducted by Enviros. Where identified the deposits were generally described as a soft to firm brown laminated clay often with sand or silt partings along laminations.

Unit	Minimum Basal Depth (m bgl)	Maximum Basal Depth (m bgl)	Comment
Glacial Till (Lower) (non-Aquifer)	2.7	17.7	Glacial Till was identified in 5 trial pits below the Tidal Flat Deposits with no Glaciolacustrine Deposits present and in all 9 boreholes which reached rockhead. Glacial Till was described as a firm to stiff red brown slightly sandy slightly gravelly clay, with gravel composed of mixed lithologies, including sandstone, limestone and rare coal. Glacial till is distributed widely across the site overlying the bedrock. This finding is in line with the previous environmental investigation of the Cleveland Works conducted by Enviros. Large lenses of sand or very sandy clay were identified in Prairie_AUK_BH101 and Prairie_AUK_BH105.
Redcar Mudstone Formation (Secondary (Undifferentiated) Aquifer)	6.8	8.7	The surface of the Redcar Mudstone Formation was identified as a weak to medium strong locally weathered grey blue mudstone, consistent with the geological map for the site. Only identified as a thin unit in Prairie_AUK_BH109 and in Prairie_AUK_BH106.
Penarth Group (Secondary (Undifferentiated) Aquifer)	8.7	11.8	Recovered as a medium strong grey siltstone. Recorded in Prairie_AUK_BH109 underlying the Redcar Mudstone Formation.
Mercia Mudstone (Secondary B Aquifer)	7.7	20.8	An extremely weak to medium strong red brown mudstone partially weathered with numerous gypsum veins and inclusions. Recorded in three boreholes.

Trial pits were not advanced to natural deposits in all cases. Reasons for shallow termination included encountering groundwater, hard strata, or the pit stability.

Made Ground was encountered in all intrusive locations and proven to a maximum thickness of at least 5m (Prairie_AUK_TP199). The base of the Made Ground was not proven in 58 of the 122 trial pits therefore, greater thickness of material may exist across the site. The distribution of the thickness of Made Ground is presented as Figure 5 and in Appendix A.

Figure 5: Thickness of Made Ground Identified

Three types of Made Ground were noted:

- **Slag-dominant material (>50% slag):** Generally ranging from gravel to cobble and occasional boulder size fragments. The slag material was generally vesicular and grey-green in colour. Discolouration of the slag surface was also noted with white crystallisation/discolouration often noted on the outer surface along with occasional iron rich areas. Slag dominant made ground was identified to comprise the primary made ground in 24 of the 122 trial pits.
- **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.
- **Cohesive Made Ground:** Frequently identified below the granular Made Ground and comprising a sandy and or gravelly clay with demolition materials within the matrix.

Two different natural deposits were identified immediately underlying the Made Ground. Tidal Flat Deposits were identified in 41 locations, and Glaciolacustrine Deposits were identified in 22 locations. In 24 further locations Glaciolacustrine deposits were identified below the Tidal Flat Deposits. Glacial Till was identified below the Tidal Flat Deposits in five locations.

The Tidal Flat Deposits and Glaciolacustrine Deposits were underlain by between 0.5m (Prairie_AUK_BH109) and 7.1m (Prairie_AUK_BH101) of Glacial Till in all boreholes. Sand or gravel rich lenses were identified within

the Glacial Till in Prairie_AUK_BH101 (1.4m thick very sandy clay) and Prairie_AUK_BH105 (2.4m clayey very sandy gravel).

The upper surface of the Redcar Mudstone Formation was proven to underly the superficial deposits in two of the ten locations and was recovered as a blue grey weak to medium strong mudstone. In seven locations the Mercia Mudstone was identified (borehole Prairie_AUK_BH102 refused in Made Ground), recovered as a weak to medium strong red brown mudstone. The Penarth Group was identified in Prairie_AUK_BH109 as a siltstone underlying the Redcar Mudstone. The bedrock was noted to dip to the north west.

2.5 Obstructions

In addition to the boulders of slag, occasional fused slag and demolition rubble which presented issues with progression of a number of the exploratory holes, further buried obstructions were identified during the course of the investigation. Detail on the obstructions is presented on the trial pit logs and summarised on Figure 6 and in Appendix A.

It should be noted that further obstructions may be encountered in areas not investigated.

Figure 6: Obstructions Identified

2.6 Hydrogeology

Previous investigations have indicated that shallow groundwater is present and was encountered between 0.5m and 2.5m bgl (Enviros 2008, MD2 2011). The site is not located within a Groundwater Source Protection Zone.

Made Ground

Groundwater was encountered in 56 out of 112 trial pits at depths of between 0.3m and 3.5m bgl, and noted to be associated with the Made Ground with infiltration rates into the pits ranging between “low” to “heavy”. Groundwater is believed to be perched within the more granular horizons (and also within sub surface structures) and flow dictated by localised preferential pathways. It was noted that groundwater levels within the Made Ground showed considerable variation between adjacent trial pits indicating that groundwater is not continuous in Made Ground across the site. Detail on the groundwater observations noted within trial pits is presented on the trial pit logs and summarised on Figure 7 and in Appendix A.

Figure 7: Groundwater Within Made Ground

Superficial Deposits

Groundwater levels recorded within the shallow superficial deposits during the site investigation are shown in the table below and on Figure 8 in Appendix A. The Tidal Flat Deposits were noted to be discontinuous across the site and where present, were of limited thickness, as such no wells were screened across this unit. It is therefore expected that although a Secondary (A) Aquifer is present regionally in the vicinity of the site the Tidal Flat Deposits are considered to be of limited resource value.

Borehole	Aquifer	Range in Depth to Groundwater (m bgl)	Range in Groundwater Elevation (m AOD)
Superficial Deposits			
Prairie_AUK_BH101S	GL	2.00	6.644
Prairie_AUK_BH101D	GT	3.00	5.644
Prairie_AUK_BH102	Made Ground	1.1	7.113
Prairie_AUK_BH103	GL	2.25	5.433
Prairie_AUK_BH105	GT	4.6	3.657
Prairie_AUK_BH106	GT	3.94	4.771
Prairie_AUK_BH107	GT	3.16	6.998
Prairie_AUK_BH108S	GL	2.2	6.663

Water was noted within the Glaciolacustrine and Glacial Till deposits although these geological units are classified as non-aquifers. Groundwater flow within the Glaciolacustrine Deposits is indicated to the north to northeast in line with the previous Enviros investigation. The flow is likely to be influenced by more granular horizons within the deposits such as those identified in Prairie_AUK_BH101D and Prairie_AUK_BH105.

In nested installation Prairie_AUK_BH101 (Glaciolacustrine Deposits over sand-rich Glacial Till) a downward head was noted between the two deposits.

Bedrock

Groundwater levels recorded within the bedrock deposits during the site investigation are shown in the table below and on Figure 8 in Appendix A. The resting groundwater levels in the monitoring wells screened across the Redcar Mudstone Formation, Penarth Group, and Mercia Mudstone are noted to be above the slotted section of the well pipe indicating the phreatic surface rests above the upper surface of the mudstone itself. It was noted that the resting groundwater elevations within the Mercia Mudstone are below those in the Glaciolacustrine Deposits (Prairie_AUK_BH208S/D) indicating a downward head.

Borehole	Aquifer	Range in Depth to Groundwater (m bgl)	Range in Groundwater Elevation (m AOD)
Prairie_AUK_BH104	Mercia Mudstone	6.4	2.296
Prairie_AUK_BH108D	Mercia Mudstone	5	3.863
Prairie_AUK_BH109	Redcar Mudstone Formation and Penarth Group	5.44	6.645
Prairie_AUK_BH110	Mercia Mudstone	4.00	3.798

The elevation data indicates that within the Redcar Mudstone Formation and Mercia Mudstone groundwater flow is to the north or north east. The two aquifers and the Penarth Group are believed to be in hydraulic continuity.

Summary

Water was noted to be variably present in Made Ground and as such, water is also expected to be present in the Tidal Flat Deposits although this has not been confirmed. The Tidal Flat Deposits are not present continuously across the site and as such, water within the deposits is not expected to represent a continuous body across the site. Although non-aquifers, the site data indicates the potential for horizontal and vertical migration of groundwater within more permeable horizons of the Glaciolacustrine Deposits and Glacial Till deposits. Aquifer permeability testing of the subsurface geology is proposed during the next round of monitoring to quantify this further. The underlying bedrock is considered the most sensitive aquifer system at the site.

It should be noted the inferred flow directions within the bedrock and Superficial Deposits are based on elevations from just a limited number of monitoring wells given the size of the site and may be influenced by local ground conditions. Two further elevation surveys are to be conducted to refine the assessment.

The results of two additional groundwater monitoring visits are presented in 10035117-AUK-XX-XX-RP-ZZ-0117-02-Prairie_ESA_Addendum.

2.7 Hydrology

The closest surface water feature to the site is the Holme Beck which runs along the western edge of the site, the watercourse is culverted as it passes through the site as both an open and covered feature. The Knitting Wife Beck is culverted below ground down the eastern side of these site. Both features flow south to north, and ultimately discharge into the River Tees via the SLEMS. The locations of these features are shown on Figure 2, and in Appendix A.

2.8 Potential Areas of Concern

Given the site history and surroundings numerous potential areas of concern (PAOC) have been identified for the site. An exhaustive review is not considered proportionate. Therefore, based on a review of the documents listed in this section, historical mapping (including site plans), and the DEFRA Magic Website https://magic.defra.gov.uk/MagicMap.aspx accessed 19th May 2020 the following PAOC have been identified. These are considered to include the PAOC considered to be of highest concern both on and off the site. The PAOC are summarised on Figure 8 and in Appendix A.

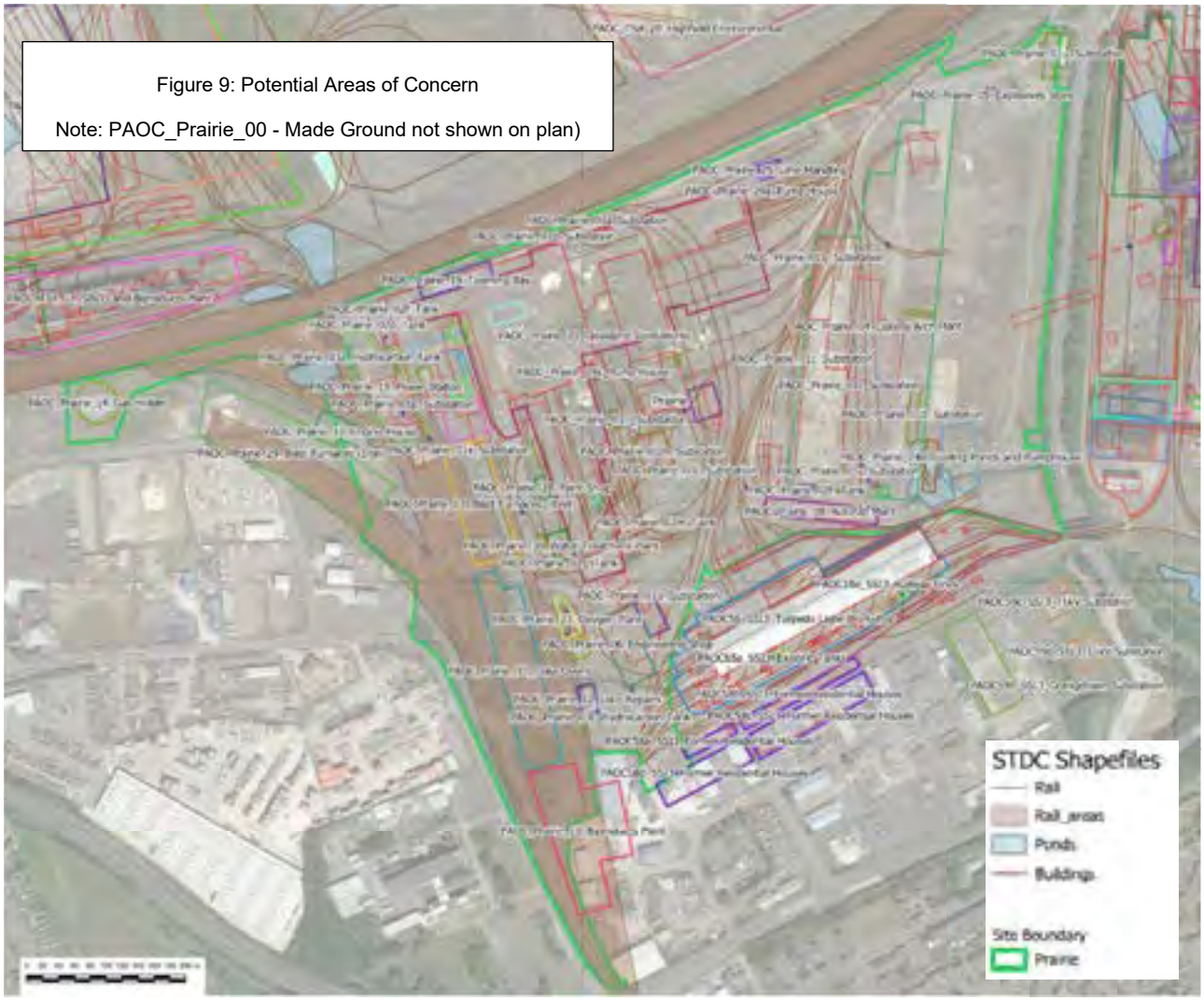

Figure 9: Potential Areas of Concern

Note: PAOC_Prairie_00 - Made Ground not shown on plan)

3 Environmental Site Condition Assessment

3.1 Introduction

This section summarises the findings of Section 2 in the form of a geo-environmental conceptual site model (CSM).

The CSM allows a qualitative evaluation of potentially active “pollutant linkages” at the site; these being plausible scenarios whereby a contamination source is connected to a possible receptor by one or more pathways:

- Potential sources of contamination: these include any actual or potentially contaminating materials and activities, located either on or in the vicinity of the site;
- Potential pathways for contamination migration: these comprise the routes or mechanisms by which contaminants may migrate from the source to the receptor including environmental migration pathways and human health exposure pathways; and
- Potential receptors of contamination: these include present and/or future land users, ecological systems, water resources and property.

The potential significance of these source-pathway-receptor linkages will be assessed in Section 4.

3.2 Contamination Sources

Based on the information reviewed in this report, the following potential contamination sources have been identified:

3.2.1 On-Site

On-site sources have been identified associated with Made Ground and potential contaminants of concern (CoC) associated with former site uses. The table below summarises the most significant potential on-site sources and the primary contaminants associated with these sources. The identified CoC are considered to represent those likely to be present from other less significant sources.

Potential On-Site sources	Primary Contaminants
Made Ground including Slag deposits	Metals including heavy metals and refractory materials, polycyclic aromatic hydrocarbons (PAHs), cyanide, thiocyanate, sulphate, pH, ammonia, and asbestos. Potential source of ground gas if found to be have a high organic content.
Coke Ovens and Biproducts Plant	Metals, asbestos, petroleum hydrocarbons (TPH) including tars, PAH, cyanides, thiocyanate, volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), chloride, ammonia, sulphate, pH
Iron and steel making facilities	Metals, asbestos, TPH, PAH, cyanides, thiocyanate, SVOCs, chloride, ammonia, sulphate, pH
Workshops, laboratories, and maintenance facilities	Metals, asbestos, TPH, PAH, acids and bases, VOCs, SVOCs, pH
Railways and sidings	Metals, asbestos, TPH, PAH, VOC, SVOC, and pH.
Above Ground Storage tanks (various)	TPH, PAH, pH.
Power station	Metals, asbestos, TPH, PAH, VOC, SVOC, polychlorinated biphenyls (PCB), and pH.

Potential On-Site sources	Primary Contaminants
Transformers	Hydrocarbons and PCBs
Infilled reservoir	Metals, asbestos, TPH including tars, PAH, cyanides, thiocyanate, VOCs, SVOCs, chloride, ammonia, sulphate, pH. Potential source of ground gas if found to be have a high organic content.

3.2.2 Off-Site

Potentially contaminative land uses have been identified in the vicinity of the site, the most pertinent of which are presented in the table with potentially associated contaminants. The identified CoC are considered to represent those likely to be present from other less significant sources.

Potential On-Site sources	Primary Contaminants
High Tip and Highfield Environmental	Metals, TPH, PAHs, VOC, SVOC, cyanide, thiocyanate, sulphate, pH, ammonia, asbestos, and ground gas.
Railway lines and sidings	Metals, asbestos, TPH, PAH, VOC, SVOC, PCB, and pH.
SBCO	Metals, asbestos, TPH including tars, PAH, cyanides, thiocyanate, VOCs, SVOCs, chloride, ammonia, sulphate, pH
Cleveland Biproducts Plant (portion now beyond the STDC boundary)	Metals, asbestos, TPH including tars, PAH, cyanides, thiocyanate, VOCs, SVOCs, chloride, ammonia, sulphate, pH
SSI3A Area - TLRS	Based on a review of investigation works by Arcadis in 2017 and 2018 the following CoC are considered to pose a potential risk to the site Human Health - Asbestos fibres in Made Ground. Water resources – Metals, ammoniacal nitrogen and PAH
SSI3B Area – BOS CONCAST Plant	Based on a review of investigation works by Arcadis in 2017 and 2018 the following CoC are considered to pose a potential risk to the site Human Health - Asbestos fibres in Made Ground. Water resources – Metals, ammoniacal nitrogen and PAH

Contaminants of concern in green are of low mobility and have therefore been discounted for the sources in question based on the distance from the site.

Based on the inferred groundwater flow direction and position relative to the site the most likely source of off-site contamination with the potential to impact the site is considered to be the portion of the Cleveland Coke Ovens Biproducts Plant now located to the south east. The risk of CoC from the High Tip, Highfield Environmental, SBCO, railway, and BOS CONCAST Plant migrating onto site are considered low.

3.3 Contamination Sources Assessment

The contamination assessment will be undertaken in two ways – contaminants that are dependent upon the material composition (e.g. metals, inorganics, asbestos and PAHs) will be assessed separately for each material type and contaminants that are associated with a particular point source (e.g. hydrocarbons) will be assessed based on the likely source.

A summary of the analytical data and statistical analysis is presented as Appendix D. Laboratory certificates will be presented as part of the AEG factual report in Appendix C.

3.3.1 Non Aqueous Phase Liquid

A non-aqueous phase liquid (NAPL) was identified in the following locations during the site investigation.

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

Plate 3 – Prairie_AUK_TP179

Sheens were noted in the following locations:

- Prairie_AUK_TP174 and
- Prairie_AUK_TP153.

NAPL has been identified in the following locations by third parties

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

A plan showing the locations where NAPL was identified in presented as Figure 9 and in Appendix A. Sheens were noted in the following locations by Enviros in 2007: TP12, TP13, TP17, and TP19.

Figure 10: Locations Where NAPL Identified

3.3.2 Made Ground

Asbestos

Asbestos was identified in thirty one samples of Made Ground , and was quantified at between <0.001 and 0.02%.. A plan showing the asbestos detections at the site is presented as Figure 10 and in Appendix A.

Figure 11: Asbestos Screen Results

Metals and Inorganics

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 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.

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. Soil samples ranged from alkaline 9.7 (slag dominant Made Ground) to neutral 7.5 (granular Made Ground).

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.

A summary of the analytical data is presented as Appendix D.

Polycyclic Aromatic Hydrocarbons

Concentrations of PAH were measured in 90 of the 101 samples analysed. 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).

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

Total Petroleum Hydrocarbons

Concentrations of TPH were detected above the MDL in approximately half of soil samples. The following samples reported concentrations of above 1,000mg/kg:

- Elevated concentration of TPH were identified in Prairie_AUK_TPH175 (3,900mg/kg at 0.8mbgl), Prairie_AUK_TPH182 (4,700mg/kg at 0.9mbgl) , Prairie_AUK_TPH194 (790mg/kg at 1.4mbgl), and Prairie_AUK_TPH196 (11,000mg/kg at 1.4mbgl). The analysis indicated the contamination was heavy end hydrocarbons of limited volatility. The PID readings for the locations were <10ppm with the exception of Prairie_AUK_TPH175 where a reading of 101.1ppm was recorded. Leachability testing identified TPH in leachate. The concentrations are inferred to be associated with the former Cleveland Coke Ovens and Biproducts Plant.
- An elevated concentration of TPH (1,700mg/kg) was measured in Prairie_AUK_TPH128 (0.9m bgl). The analysis indicated the contamination was heavy end hydrocarbons of limited volatility. This is corroborated as no elevated reading (>10ppm) was measured by a photo ionisation detector during field screening. Leachability testing identified TPH in leachate. This sample is associated with backfill around a redundant service encountered in the trial pit.
- Elevated concentrations of TPH were identified in Prairie_AUK_TPH142 (3,800mg/kg at 1.54mbgl and 8,700mg/kg at 0.9mbgl), and Prairie_AUK_TPH141 (15,000mg/kg at 2.0mbgl). The analysis indicated the contamination was heavy end hydrocarbons of limited volatility. This is corroborated as no elevated reading (>10ppm) was measured by a photo ionisation detector during field screening. Leachability testing identified TPH in leachate. The concentrations are inferred to be associated with a former water treatment plant.
- An elevated concentration of TPH (1,300mg/kg) was measured in Prairie_AUK_TPH114 (0.9m bgl), the analysis indicated the contamination was heavy end hydrocarbons of limited volatility. This is corroborated as no elevated reading (>10ppm) was measured by a photo ionisation detector during field screening. Leachability testing identified TPH in leachate. This sample is associated with backfill around a redundant service which was noted to contain tar like material encountered in the trial pit.
- An elevated concentration of TPH (910mg/kg) was measured in Prairie_AUK_TPH120A (1.0m bgl), the analysis indicated the contamination was heavy end hydrocarbons of limited volatility. This is corroborated as no elevated reading (>10ppm) was measured by a photo ionisation detector during field screening.
- An elevated concentration of TPH (730mg/kg) was measured in Prairie_AUK_TPH123 (0.6m bgl), the analysis indicated the contamination was heavy end hydrocarbons of limited volatility. This is corroborated as no elevated reading (>10ppm) was measured by a photo ionisation detector during field screening.

The locations of elevated TPH C_5 to C_{35} are shown on Figure 12 and in Appendix A.

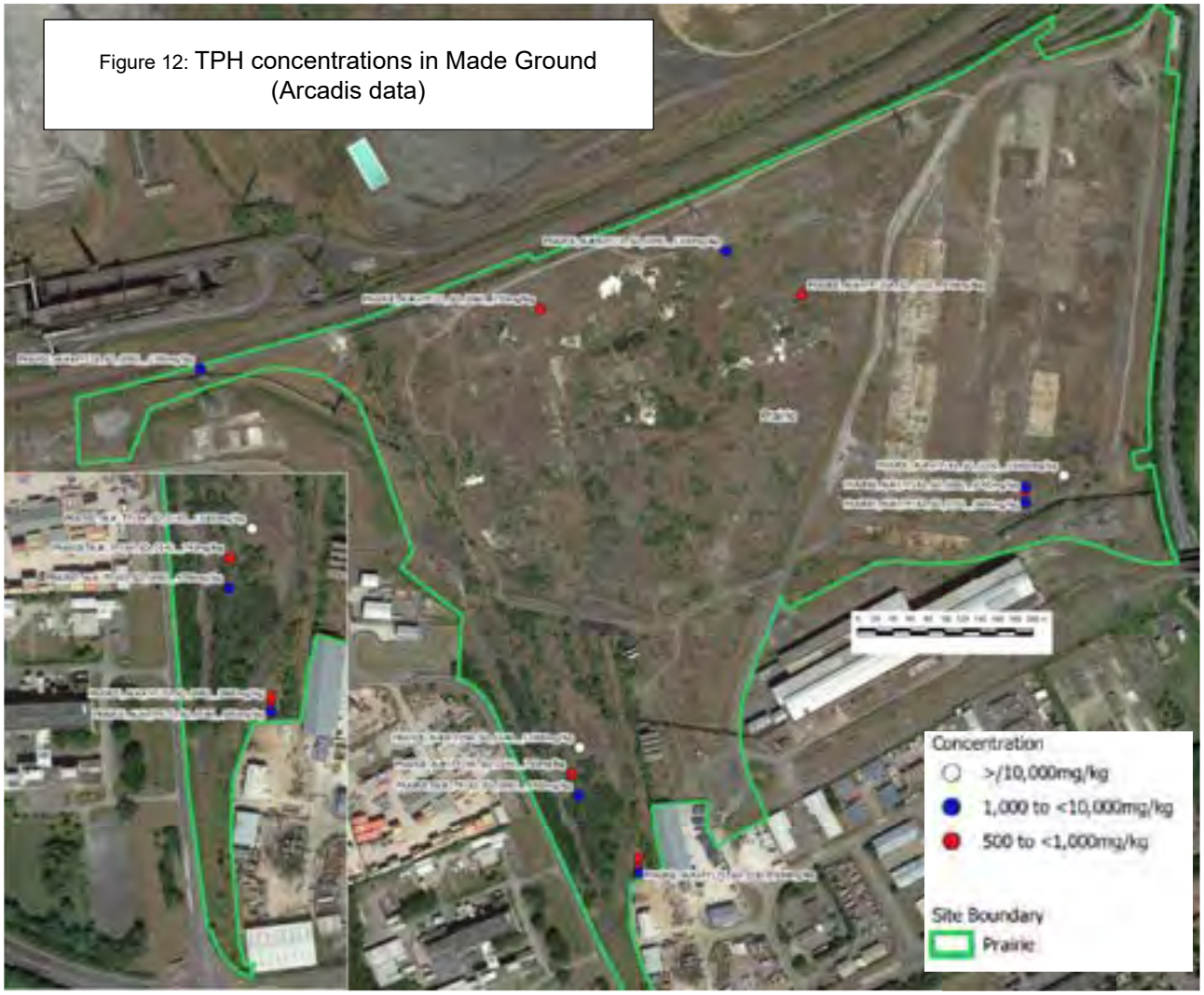

Figure 12: TPH concentrations in Made Ground (Arcadis data)

The locations of elevated TPH C_{10} to C_{35} and extractable petroleum hydrocarbons C_{10} to C_{40} (EPH) in historical third party data are shown on Figure 13 and in Appendix A.

Figure 13: TPH concentrations in Made Ground (3rd Party Data)

Other Contaminants

Low levels of VOC, SVOC, and PCBs were measured infrequently in soil samples.

3.3.3 Superficial Deposits

Concentrations of metals within the Superficial Deposits were consistent between the different geological units. 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.

3.3.4 Groundwater

Seven wells are screened across the Superficial Deposits, four across bedrock and one across the Made Ground.

Metals and Inorganics

Metals were measured in all groundwater samples; metals boron, calcium, manganese, sodium, and iron were measured at the highest concentrations. 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.

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).

Organics

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). 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.

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

3.4 Pathways

Potential migration pathways based on a proposed commercial industrial end use are discussed below.

3.4.1 Airborne Migration Pathways

- The majority of the site is currently covered in soft landscaping, as such, particulate inhalation due to dust generation is a potentially active pathway if the hardstanding or buildings were not present across the site in a future development scenario.
- Vapour inhalation pathways in relation to contaminants in soil and groundwater are potentially active, both for an exposure scenario in outdoor or indoor air space
- During potential re-development works, sub-surface soils could be exposed at the surface due to trenching and or re-profiling requirements and therefore dust has the potential to be generated. Notwithstanding this, typical dust suppression techniques should be employed so that exposures would be minimised.
- Migration and accumulation of permanent ground gases originating from the made ground on site in confined spaces leading to asphyxiation and/or explosion is considered potentially active.

3.4.2 Direct Contact Exposure Pathways

- The proposed site surfacing under any potential re-development scenario is unknown, should a significant portion of the site area be covered in some form soft landscaping direct contact and ingestion pathways in relation to soil would be considered active. Given the likely depth to groundwater (approximately 2 to 3m bgl in natural deposits, <1m bgl in some Made Ground), direct contact pathways in relation to groundwater are not considered active for groundwater within the natural deposits but potentially active for perched water within the Made Ground.
- Direct contact pathways with soils could be active throughout a potential redevelopment; typical mitigation measures such as personal protective equipment (PPE; overalls, gloves etc.) could be used to mitigate this risk. If unexpected contamination were identified during redevelopment works, additional PPE may be required as mitigation.

3.4.3 Aqueous Migration Pathways

- Leaching of contaminants in the shallow soils to groundwater within the Superficial Deposits is considered potentially active
- Based the limited thickness of Glacial Till / Glaciolacustrine Deposits identified in some on-site boreholes between the Tidal Flat Deposits and the underlying bedrock the potential for vertical migration of contaminants to the underlying bedrock aquifers is considered potentially active.
- Given the granular nature of the identified and thickness of the Made Ground and the permeability of the Superficial Deposits lateral migration of off-site impacts onto the site from off-site PAOC is considered potentially active. The most likely source (Section 3.2.2) would be impacts associated with the former Cleveland Coke Ovens Biproducts Plant now located south of the site boundary.
- Lateral migration of on-site impacts towards the Holme Beck and Knitting Wife Beck watercourses is considered potentially active given the identified thickness and nature of the Made Ground and the

permeability of the Superficial Deposits. The potential for infiltration of CoC into open sections of the Holm Beck via surface runoff or migration of rainfall through the made ground is considered active.

- Vertical migration of impacts down relic foundation piles is considered potentially active.

3.5 Receptors

With reference to Part 2a of the Environmental Protection Act (1990), the potential receptors to be considered in any contaminated land scenario can be summarised as follows:

3.5.1 Human Health

For the purposes of this assessment it is assumed that the proposed development will comprise a commercial or industrial end use, and as such commercial and industrial workers are the primary receptor of concern for any contamination risk. The risk would be influenced by the duration and location of the staff work regimes.

Users of the adjacent buildings (industrial workers and neighbouring residents) could also be at risk. However, for exposure to occur, active cross-boundary migration pathways would be required. It is noted that the neighbouring residents are situated approximately 70m hydraulically upgradient of the site, as such are not considered to be at significant risk from the site.

3.5.2 Property (buildings, etc)

The proposed development will include new structures and associated infrastructure, which could be subject to potential sulphate attack in relation to buried concrete. Given the presence of slag deposits within the Made Ground the potential for expansive slag to impact structures is considered active.

3.5.3 Controlled Water

Groundwater is a Controlled Water; therefore, the groundwater beneath the site requires consideration and protection. At this site, the underlying geology comprises Tidal Flat Deposits which are classified as a Secondary (A) Aquifer, the Mercia Mudstone Formation classified as a Secondary (B) Aquifer, and the Redcar Mudstone Formation / Penarth Group classified as a Secondary (Undifferentiated) Aquifers all of which are considered groundwater receptors at the site. The Glacial Till and Glaciolacustrine Deposits which underly the Tidal Flat Deposits and overly the bedrock are not classed as aquifers by the Environment Agency.

Surface water courses are also considered Controlled Water receptors; given the presence of the Holme and Knitting Wife Becks crossing the site these are considered the primary surface water receptors and the most sensitive receptors for the site, albeit noting that the presence of culverting will impact upon the actual risk presented.

3.5.4 Ecological

The Teesmouth and Cleveland Coast SSSI which includes a section of the River Tees is located approximately 745m north of the Site, and within 2km north west and south west of the area. The Teesmouth and Cleveland Coast is also designated as an SPA and RAMSAR.

Based on the distance from the site the risk to ecological receptors is considered low. In addition potential discharges from the site to the Teesmouth and Cleveland Coast SPA and RAMSAR via the River Tees are likely to be limited by tidal exchange and the large volume of the River Tees receiving water. This is in line with the findings of Wood 2019.

3.6 Obstructions

Frequent relic structures presented issues with progression of a number of the exploratory holes during the course of the investigation It should be noted that further obstructions may be encountered in areas not investigated.

3.7 Slag Testing Data

Petrographic and expansion examination was conducted on five samples from the site, the results are were not compete due to Covid-19 restrictions at the time of issue, and have subsequently been presented in 10035117-AUK-XX-XX-RP-ZZ-0117-02-Prairie_ESA_Addendum.

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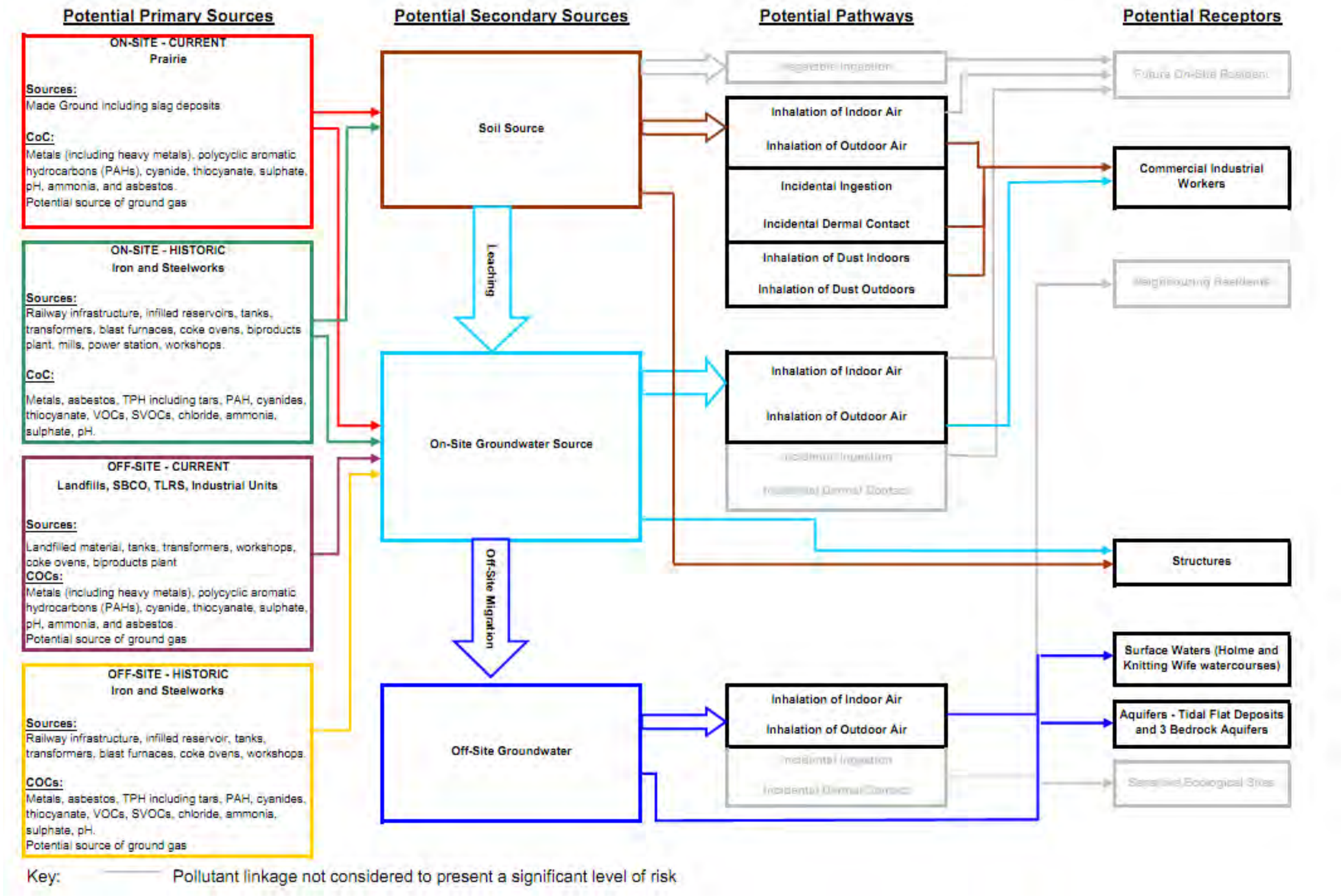
3.8 Conceptual Site Model

The above data has been used to produce a CSM for the site, this is presented below as Figure 14 and in Appendix A..

Figure 14
Outline Conceptual Site Model - Commercial Industrial End Use



4 Generic Quantitative Risk Assessment

4.1 Tiered Approach

The purpose of this assessment is to quantify potential risks to the human health, controlled waters and built receptors identified in the CSM in relation to the redevelopment of the site for a continued commercial/industrial use.

The following scenarios are not considered in this section:

- Risks to Construction Workers – any redevelopment and construction work should be conducted in full recognition of HS(G)66.
- Nuisance health effects – the Statutory Nuisance Act considered olfactory impacts from odours and allows comparison of enclosed space air concentrations with odour threshold concentrations.
- An assessment of the geotechnical development constraints which is outside the scope of this document.

Assessment of risks arising from soil and groundwater contamination are assessed in accordance with the framework presented in Contaminated Land Report 11 (CLR 11) (EA, 2004) and Land Contamination: Risk Management (LC:RM) (EA, 2020). This sets out a tiered approach to risk assessment comprising:

- Generic Quantitative Risk Assessment (GQRA) - Comparison of site contaminant levels against generic standards and compliance criteria including an assessment of risk using a source-pathway-receptor model.
- Detailed Quantitative Risk Assessment (DQRA) - Derivation of site-specific risk assessment criteria and calculation of site specific clean-up goals.

In this section, a GQRA has been carried out. The potential identified pollutant linkages identified in the preliminary CSM for human health and controlled water receptors have been assessed by comparison against relevant generic assessment criteria (GAC). These have been derived using conservative assumptions to enable potential pollutant pathways that do not pose unacceptable risks to be identified and discounted. Exceedance of a GAC does not imply that an unacceptable risk is necessarily present, rather that further assessment may be required to verify the potential risk.

It is assumed that the site will be redeveloped as a typical commercial industrial development comprising office buildings, hardstanding and some areas of soft landscaping. The site has not been zoned at this stage and all data has been considered on an individual sample basis.

4.2 Human Health Risks

4.2.1 Selection of Soil GAC

Potentially active pollutant linkages and contaminants of concern (CoC) in relation to human health risks have been identified in the initial CSM as:

A. Vapour inhalation of indoor and outdoor air from volatile contamination in soils, (potential CoC include volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs)),

B. Vapour inhalation of indoor and outdoor air from volatile contamination in shallow groundwater, (potential CoC include VOCs and SVOCs)

C. Dermal contact/ingestion of soil (potential CoC include heavy metals, organic/inorganic compounds)

D. Dust inhalation (potential CoC include asbestos and heavy metals)

For the purposes of this assessment it is assumed that the proposed refurbishment / re-development will comprise a commercial or industrial end use and, as such, commercial and industrial workers are the primary receptor of concern for any contamination risk. The risk would be influenced by the duration and location of

the staff work regimes. For the basis of this assessment, it is assumed that site workers will be on-site for a "standard" 8 hour working day.

Commercial end use assumes a pre-1970s commercial property is present at the site with some open areas uncovered by hardstanding and is therefore regarded as conservative for a redevelopment scenario as new structures are assumed to be constructed to current standards.

To assess potential linkages A, C and D above, GAC have been chosen, based on an assumed industrial/commercial end use. Criteria published by authoritative industry bodies and commonly accepted by regulators for use under the planning regime for development sites have been used first. For contaminants for which no published values are available, Arcadis derived criteria (developed following the CLEA framework (v1.07)) or foreign national criteria have been used.

The GAC comprise (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) (USEPA, 2018)

Wood derived GAC based on CLEA v1.07 which were presented in the Wood 2019 report for benzo(a)pyrene and naphthalene. It is understood that these values were acceptable to the regulator for this site and as such they have been retained here.

Soil organic matter recorded in 117No. soil samples obtained from the site ranged from 0.4 to 14%. The organic matter analysis indicated mean values of 1.7% in slag dominant Made Ground, 2.85% in cohesive Made Ground, and 3.7% granular Made Ground. As such, the S4UL selected as GAC are those for a commercial end use assuming a soil organic matter (SOM) content of 1% (suitably conservative).

The selected human health GAC for soil are presented in Appendix E:

4.2.2 Soil Risk Assessment

Contaminant concentrations in soil samples have been compared with the soil GAC in Appendix E. Contaminants which are in excess of the GAC are summarised below. Contaminants that are not in excess of the respective GAC are not considered to present a significant risk and do not require further assessment in relation to the redevelopment of the site unless the above assumptions are not valid.

The following samples were analysed:

- 15 No. samples of slag-dominated Made Ground
- 77 No. samples of granular Made Ground
- 6 No. samples of cohesive Made Ground
- 10 No. samples of Tidal Flat Deposits
- 6 No. samples of Glaciolacustrine Deposits
- 2 No. samples of Glacial Till

Eight of the samples were granular Made Ground and 2No. samples were slag-dominated Made Ground and one from the Tidal Flat Deposits. Samples tested were taken across the site from depths ranging from surface to 5.4m bgl. Contaminant concentrations that exceeded the GAC are listed below.

Contaminant	Unit	No. Samples Exceeding	GAC Exceeded		Sample (Geology)	Concentration (mg/kg)
Arsenic	mg/kg	1/117	S4UL	640	PRAIRIE_AUK_TP162_SO_0170	2,100
Naphthalene	mg/kg	2/117	Wood	1,900	PRAIRIE_AUK_TP114_SO_0090 PRAIRIE_AUK_TP182_SO_0090	37,000 3,500
Phenanthrene	mg/kg	1/117	S4UL	22,000	PRAIRIE_AUK_TP114_SO_0090	22,000
Benzo(a)anthracene	mg/kg	1/117	S4UL	170	PRAIRIE_AUK_TP114_SO_0090	4,600
Chrysene	mg/kg	1/117	S4UL	350	PRAIRIE_AUK_TP114_SO_0090	3,600
Benzo(b)fluoranthene	mg/kg	1/117	S4UL	44	PRAIRIE_AUK_TP114_SO_0090	91
Benzo(a)pyrene	mg/kg	2/117	Wood	77	PRAIRIE_AUK_TP114_SO_0090 PRAIRIE_AUK_TP175_SO_0080	92 120
Dibenzo(a,h)anthracene	mg/kg	2/117	S4UL	3.5	PRAIRIE_AUK_TP114_SO_0090 PRAIRIE_AUK_TP175_SO_0080	8.4 15
Dibenzofuran	mg/kg	1/117	USEPA	1,000	PRAIRIE_AUK_TP114_SO_0090	3,300

Contaminants for which no screening criteria were available have been reviewed. Most contaminants were recorded below the method detection limit (MDL) in all soil samples.

Contaminants measured in soil at concentrations above MDL, for which no screening criteria were available were: aluminium, iron, magnesium, manganese, silicon, total cyanide, sulphate, sulphur, some PCBs, isopropylbenzene, p-isopropyltoluene and carbozole. Potential human health risks from these are qualitatively assessed in Section 4.2.6.

Contaminant concentrations that exceeded the GAC are shown on Figure 15 in Appendix A. Maximum recorded concentrations in soil for all contaminants are listed in Appendix E.

4.2.2.1 Third Party Historical Data

Contaminant concentrations in soil samples collected as part of historical site investigations have been compared with the soil GAC in Appendix E. Contaminants which were measured in excess of the GAC are summarised below. Contaminants that do not exceed the respective GAC are not considered to be present a significant risk and do not require further assessment in relation to the redevelopment of the site unless the above assumptions are not valid.

Contaminant	Unit	GAC Exceeded		Sample	Concentration (mg/kg)
Benzo(a)anthracene	mg/kg	S4UL	170	Enviros 2007 TP34 (0.5mbgl)	180
Benzo(b)fluoranthene	mg/kg	S4UL	44	Enviros 2007 TP34 (0.5mbgl)	210
Benzo(a)pyrene	mg/kg	S4UL Wood	35 77	Enviros 2007 TP34 (0.5mbgl) Shadbolt 2011 BH07A (0.2mbgl)	140 42.4
Dibenzo(a,h)anthracene	mg/kg	S4UL	3.5	Enviros 2007 TP34 (0.5mbgl)	23

Contaminant	Unit	GAC Exceeded		Sample	Concentration (mg/kg)
				Enviros 2007 TP7 (0.5mbgl)	4.5
				Enviros 2007 TP/WS4 (0.5mbgl)	4.3
				Shadbolt 2011 BH07A (0.2mbgl)	10.5
				Shadbolt 2011 BH11 (0.5mbgl)	4.4

The concentrations measured by third parties in excess of the GAC were all PAHs and are in line with the 2020 data collected by Arcadis. Contaminant concentrations that exceeded the GAC are shown on Figure 15 in Appendix A.

4.2.3 Selection of Groundwater GAC

To assess the potential risk to human health via pollutant linkage B above (inhalation of volatile contaminants in groundwater), inhalation GAC have been derived by Arcadis for volatile contaminants in groundwater.

These have been derived by Arcadis using the CLEA process and industry standard vapour transport modelling (Johnson & Ettinger model). The same assumptions relating to a commercial end use of the site have been included in the model and an on-site commercial worker has been considered as the receptor.

The inhalation GAC are listed in Appendix F and G.

4.2.4 Groundwater Risk Assessment

Concentrations of volatile contaminants in 12 groundwater samples were screened against the inhalation GAC described above (where GAC have been derived).

The vapour inhalation GAC are designed to determine whether there is a significant risk of harm to human health from inhaling volatile contaminants emanating from groundwater beneath the site (potential pollutant linkage B in the preliminary CSM in Section 4.2).

None of the concentrations of volatile contaminants measured in groundwater were in excess of the inhalation GAC for on-site commercial workers. As such, the risk to human health from measured concentrations of CoC in groundwater is not considered to be significant.

Volatile contaminants for which no GAC are readily available and which were measured above MDL were styrene, isopropylbenzene, 2-chlorotoluene, 1,3,4-trimethylbenzene, 1,2,4-trimethylbenzene and 1,2-dibromo-3-chloropropane. The risk to human health from these contaminants will be considered further in Section 4.2.7.

4.2.5 Asbestos in Soil

A total of 117No. soils samples were screened by polarised light microscopy in accordance with HSG248 for the presence of asbestos (HSE, 2005). In 31No. samples asbestos was detected as bundles of fibres (chrysotile and amosite).

Quantification of the asbestos was carried out on 31No. samples by gravimetric methods, the samples recorded asbestos mass between <0.001% and 0.020%. The distribution of asbestos detections is shown on Figure 9 in Appendix A.

The presence of quantifiable levels of asbestos in soil warrants further consideration. Asbestos in shallow soils in areas without buildings or hardstanding has the potential to become airborne and available for inhalation, particularly during construction, posing chronic risks to human health.

4.2.6 Qualitative Risk Assessment for Substances in Soil without GACs

As shown in Appendix E, several contaminants including PCBs, some metals, inorganics, VOCs and SVOCs do not have a GAC available, the majority were recorded at less than the MDL in all soil samples. Based on a review of the MDLs, these are not considered to pose a significant risk, especially given the relatively low MDLs obtained.

The following did not have a GAC and were recorded at concentrations in excess of their MDL: aluminium, iron, magnesium, manganese, silicon, total cyanide, sulphate, sulphur, some PCBs, isopropylbenzene, p-isopropyltoluene and carbozole. Of these, aluminium, iron, magnesium, manganese, silicon, sulphate and sulphur are present naturally in soil and some are biologically required nutrients. They may be elevated above natural levels where slag and other steelmaking wastes are incorporated into soil due to the site's former use, particularly manganese and iron. However, regardless of these elevations, their typically low toxicity is likely to mean these occurrences present a low risk of adverse harm following development, in particular if the ground is covered by buildings, hardstanding or permanent landscaping.

Some contaminants, such as total cyanide, can be assessed under other GAC for higher toxicity contaminants, such as the one for free cyanide for a conservative estimate of risk. Concentrations of total cyanide are in excess of the GAC and as such require further consideration in Section 4.2.8.

PCBs were measured above MDL in three samples of Made Ground collected from the site up to two orders of magnitude above the MDL. As such further consideration will be given to concentrations of PCBs in Section 4.2.8.

The VOCs isopropylbenzene and p-isopropyltoluene were detected marginally above MDL (within an order of magnitude of the MDL). Given the concentrations measured, these contaminants are not considered to represent a significant risk to human health.

Carbazole was detected above MDL in 12 of 23 soil samples analysed. It is indicative of incomplete combustion products and therefore consistent with the presence of steelmaking wastes. Given the distribution of the contaminant in the soil samples and that the maximum concentration measured in several orders of magnitude above the MDL, further consideration will be given to concentrations of carbazole in Section 4.2.8.

It is noted that substances analysed for as part of this investigation without GACs are typically considered to be those with low known toxicity, or incomplete toxicity information. In the absence of suitable toxicity information, the applicable regulators have not defined screening values. As such, further action with regards to these substances is unlikely to be mandated by the local authority, and the below recommendations are likely to adequately manage the risk to human health and the environment.

Other effects, such as phytotoxicity, are not assessed as the Made Ground is likely to be unsuitable as a growing medium and some form of capping with "clean" soil is likely to be incorporated into the development.

4.2.7 Qualitative Risk Assessment for Substances in Groundwater Without GAC

As shown in Appendix G, several contaminants including some metals and VOCs do not have a GAC available. Many were not measured above MDL in groundwater. Based on a review of the MDLs, these are not considered to pose a significant risk, especially given the relatively low MDLs obtained.

The following did not have a GAC and were recorded at concentrations in excess of their MDL: styrene, isopropylbenzene, 2-chlorotoluene, 1,3,4-trimethylbenzene, 1,2,4-trimethylbenzene and 1,2-dibromo-3-chloropropane. Of the 6 contaminants, 3 were measured at concentrations marginally in excess of the MDL (within the same order of magnitude) and as such are not considered to represent a significant risk to human health (styrene, isopropylbenzene, 2-chlorotoluene).

1,3,4-trimethylbenzene and 1,2,4-trimethylbenzene are both compounds which are typically found in hydrocarbon fuels. Both compounds were measured above MDL in one groundwater sample only, taken from BH109. The maximum concentration of TPH was identified in the same groundwater sample. On this basis it is likely that both 1,3,4-trimethylbenzene and 1,2,4-trimethylbenzene are related to TPH and as such, TPH and BTEX compounds are appropriate as indicator compounds to indicate the risk to human health. Concentrations of TPH and BTEX compounds have not been identified above the GAC derived for the protection of human health, as such the risk to human health receptors from 1,3,4-trimethylbenzene and 1,2,4-trimethylbenzene is considered to be low.

1,2-dibromo-3-chloropropane was measured at concentrations an order of magnitude greater than the MDL in groundwater sampled from one location screening the Glaciolacustrine Deposits (BH101S). Given the concentration is relatively low (two orders of magnitude lower than the lowest GAC available for VOC) and that the compound appears to be relatively localised (measured above MDL in one sample out of 12) the risk to human health receptors is likely to be low.

4.2.8 Discussion

Concentrations of arsenic were measured in one soil sample above the GAC protective of human health via potential pollutant linkage C and will need to be considered in the remedial strategy. A readily available GAC for total cyanide was not identified and it was measured at concentrations above the GAC for free cyanide, albeit free cyanide is more toxic than total cyanide so this is a very conservative estimate of risk. In the absence of directly comparable GAC, total cyanide will need to be considered in the remedial strategy via pollutant linkage C.

PAHs were measured in excess of the GAC protective of human health via pollutant linkage A and C. The concentrations measured in excess of the GAC for human health were in soil sampled from Granular Made Ground and require further consideration. Further consideration will also be given to PCBs and carbazole for which there are no readily available GAC for comparison.

To further assess the risk to human health (future on-site commercial worker) from measured concentrations of PCBs, PAHs and carbazole in soil via the vapour inhalation pathway – driven by vapour intrusion (pollutant linkage A), the CoC have been screened on the basis of Henry's Law Constant. This constant relates the contaminant concentration in the vapour phase, to its concentration in the (pore) water phase. Those CoC with a Henry's Law Constant of less than 1 x 10^{-5} atm.m^3/mol are considered insufficiently volatile to pose a risk via volatilisation into indoor / outdoor air. This method is based on the method described by Lyman et al., (1982), where the following definitions are made:

KH < 10^{-7} atm.m^3/mol (low volatility)

KH > 10^{-7} and < 10^{-5} atm.m^3/mol (volatilise slowly)

KH > 10^{-5} and < 10^{-3} atm.m^3/mol (volatilisation is an important transfer mechanism)

KH > 10^{-3} atm.m^3/mol (volatilisation will proceed rapidly)

This approach is in line with current UK guidance including Construction Industry Research and Information Association (CIRIA) (2009) and SNIFFER (2003). The results of the screening process are summarised below.

Analyte	Henry's Law Constant (atm.m^3/mol)	Further Assessment Required
Naphthalene	1.62x10^{-4}	Yes*
Benzo(a)anthracene	7.73 x10^{-7}	No**
Chrysene	7.78x10^{-8}	No**
Benzo(b)fluoranthene	5.02x10^{-8}	No**
Benzo(a)pyrene	4.31x10^{-8}	No**
Dibenzo(g,h,i)perylene	1.3x10^{-7}	No**
PCB 7 Total	3.55x10^{-5}	No**
Carbazole	5.11x10^{-7}	No**
Dibenzofuran	5.82x10^{-5}	No**

* Naphthalene has failed the screening process as its Henry's Law Constant was greater than 1x10^{-5} atm.m^3/mol.

** Given that their Henry's Law Constants are lower than 1x10^{-5} atm.m^3/mol, the concentrations encountered at the site are not deemed to pose a significant risk to the human health receptors via the vapour inhalation pathway. Therefore, they have not been considered further in relation to pollutant linkage A.

Concentrations of the contaminants assessed using Henrys Law, with the exception of naphthalene, are not considered to represent a risk via pollutant linkage A. They will need to be considered with regard to pollutant linkage C as part of the remedial strategy for the site.

Naphthalene is sufficiently volatile to pose a risk to human health via pollutant linkage A. The highest concentration of naphthalene was identified in soil associated with a pipe containing tar. Material of this nature would be considered to be impacted and removed as part of the remedial strategy prior to the development of site. The second highest concentration of naphthalene, and only other concentration of naphthalene identified in excess of the GAC, was in the same order of magnitude as the GAC. Further assessment of the risk to human health from naphthalene is required.

It is noted that the USEPA GAC do not consider the risk via the vapour intrusion pathway and as such, where VOC have been measured above MDL in soil and compared to USEPA GAC, this does not assess the risk via pollutant linkage A. Review of these compounds (styrene, 1,3,5-trimethylbenzene, tert-butylbenzene and 1,2,4-trimethylbenzene) indicates that they are typically associated with hydrocarbon fuel. As such, it is considered appropriate to consider the risk to human health via vapour inhalation from these compounds using hydrocarbon indicator compounds including TPH and BTEX. Concentrations of TPH and BTEX have not been identified above the GAC derived for the protection of human health and as such, a significant risk to human health has not been identified.

Free cyanide was also assessed using the USEPA GAC, although measured below this screening criteria the GAC does not consider the vapour inhalation pathway (pollutant linkage A), as such the risk to human health cannot be discounted at this point and further consideration of free cyanide is warranted.

Asbestos fibres were identified in 31 No. soil samples. Asbestos is potentially hazardous when inhaled and therefore pollutant linkage D (inhalation of dust) is considered potentially active as surface soils may become airborne during construction or if incorporated into soft landscaping without any cover.

Acute risks to construction workers arising from short-term contact with contaminated soils during demolition and redevelopment of the site are not assessed by the chronic risk assessment methods in this report. During construction works, site workers should remain vigilant to the possible risk of encountering isolated areas of contaminated material. Should potentially contaminated material be encountered, further testing may be required to assess the risk to health and safety of the site workers and the environment. All persons engaged in site construction works should be made aware of the findings of the intrusive investigation and the hazards associated with handling potentially contaminated materials. It is recommended that all works are conducted in accordance with the Health and Safety Executive publication entitled “Protection of Workers and the General Public during the Development of Contaminated Land” (HSE, 1991).

4.3 Risks to Controlled Waters

4.3.1 Selection of GAC

Potentially active pollutant linkages in relation to Controlled Waters have been identified in the initial CSM as:

1) Leaching of CoC from Made Ground to groundwater in Tidal Flat Deposits
2) Vertical Migration of CoC to Redcar Mudstone Formation, Penarth Group, or Mercia Mudstone
3) Horizontal Migration of contaminated groundwater to the on-site watercourse
4) Migration of CoC in groundwater onto site from off-site sources
5) Migration of CoC in groundwater off site.

An assessment of the potential for soluble contaminants in the Made Ground and slag on the Site to impact the Controlled Waters receptors identified in the CSM (on-site surface water and underlying Secondary Aquifers (Tidal Flat Deposits and bedrock) has been undertaken.

Concentrations of leachable contaminants from soil leaching tests and groundwater samples have been compared to appropriate Water Quality Standards (WQS).

The WQS chosen are UK Drinking Water Standards (DWS) protective of aquifer water resources, and Environmental Quality Standards (EQS) considered protective of surface waterbody quality. The EQS are for saline waters protective of the Tees Estuary receptor. The WQS are listed in Appendix G.

4.3.2 Soil Leachate

The results of 24No. soil leachate tests were compared to the WQS as shown in Appendix F. Contaminant concentrations that exceeded the WQS are shown in the table below. Seventeen of the samples were granular Made Ground, 4No. samples were slag-dominated Made Ground, and 3No. of cohesive Made Ground. Samples tested were taken across the site from depths ranging from 0.6 m to 3.6m bgl.

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
Antimony	µg/l	2/24	DWS	5	PRAIRIE_AUK_TP141_SO_0200 PRAIRIE_AUK_TP142_SO_0150	14 18
Arsenic	µg/l	1/24	DWS	10	PRAIRIE_AUK_TP142_SO_0150	41
Hexavalent Chromium	µg/l	1/24	EQS	0.6	PRAIRIE_AUK_TP110_SO_0100	8.1
Copper	µg/l	7/24	EQS	3.76	PRAIRIE_AUK_TP123_SO_0060 PRAIRIE_AUK_TP128_SO_0090 PRAIRIE_AUK_TP140_SO_0100 PRAIRIE_AUK_TP142_SO_0150 PRAIRIE_AUK_TP144_SO_0080 PRAIRIE_AUK_TP145_SO_0160 PRAIRIE_AUK_TP181_SO_0060	22 5.8 4.2 30 6.4 4.2 5.6
Lead	µg/l	2/24	EQS and DWS	1.3 10	PRAIRIE_AUK_TP142_SO_0150 PRAIRIE_AUK_TP181_SO_0060	16 4.2
Manganese	µg/l	9/24	DWS	50	PRAIRIE_AUK_TP110_SO_0100 PRAIRIE_AUK_TP128_SO_0090 PRAIRIE_AUK_TP163_SO_0120 PRAIRIE_AUK_TP170_SO_0100 PRAIRIE_AUK_TP175_SO_0080 PRAIRIE_AUK_TP179_SO_0140 PRAIRIE_AUK_TP182_SO_0090 PRAIRIE_AUK_TP194_SO_0140 PRAIRIE_AUK_TP196_SO_0140	160 98 400 180 52 890 86 330 580
Mercury	µg/l	3/24	EQS and DWS	0.07 1	PRAIRIE_AUK_TP140_SO_0100 PRAIRIE_AUK_TP141_SO_0200 PRAIRIE_AUK_TP142_SO_0150	0.17 0.27 1.2
Nickel	µg/l	2/24	EQS	8.6	PRAIRIE_AUK_TP141_SO_0200	11

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_TP142_SO_0150	18
Zinc	µg/l	4/24	EQS	7.9	PRAIRIE_AUK_TP103_SO_0100 PRAIRIE_AUK_TP110_SO_0100 PRAIRIE_AUK_TP170_SO_0100 PRAIRIE_AUK_TP201_SO_0360	10 15 15 33
Ammoniacal Nitrogen	µg/l	4/24	DWS	0.5	PRAIRIE_AUK_TP141_SO_0200 PRAIRIE_AUK_TP142_SO_0150 PRAIRIE_AUK_TP175_SO_0080 PRAIRIE_AUK_TP179_SO_0200	0.91 3.2 1.6 1.2
Aromatic C5-C7	µg/l	2/24	DWS	1	PRAIRIE_AUK_TP128_SO_0090 PRAIRIE_AUK_TP136_SO_0080	4.5 6.6
TPH	µg/l	13/24	EQS	50	PRAIRIE_AUK_TP108_SO_0200 PRAIRIE_AUK_TP110_SO_0100 PRAIRIE_AUK_TP114_SO_0090 PRAIRIE_AUK_TP128_SO_0090 PRAIRIE_AUK_TP136_SO_0080 PRAIRIE_AUK_TP141_SO_0200 PRAIRIE_AUK_TP142_SO_0150 PRAIRIE_AUK_TP144_SO_0080 PRAIRIE_AUK_TP170_SO_0100 PRAIRIE_AUK_TP175_SO_0080 PRAIRIE_AUK_TP179_SO_0140 PRAIRIE_AUK_TP182_SO_0090 PRAIRIE_AUK_TP194_SO_0140	340 120 3,700 17,000 110 920 1,900 140 120 130 880 8,500 53
Naphthalene	µg/l	11/24	EQS DWS	2 2	PRAIRIE_AUK_TP103_SO_0100 PRAIRIE_AUK_TP114_SO_0090 PRAIRIE_AUK_TP128_SO_0090 PRAIRIE_AUK_TP141_SO_0200 PRAIRIE_AUK_TP163_SO_0120 PRAIRIE_AUK_TP175_SO_0080 PRAIRIE_AUK_TP179_SO_0140 PRAIRIE_AUK_TP179_SO_0200 PRAIRIE_AUK_TP182_SO_0090 PRAIRIE_AUK_TP194_SO_0140	4.6 10,000 230 2.5 3.2 890 2,300 50 11,000 57

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_TP196_SO_0140	34
Benzo(b)fluoranthene	µg/l	24/24	EQS and DWS	0.017 and 0.025	PRAIRIE_AUK_TP103_SO_0100	210
					PRAIRIE_AUK_TP108_SO_0200	0.65
					PRAIRIE_AUK_TP110_SO_0100	13
					PRAIRIE_AUK_TP112_SO_0210	0.3
					PRAIRIE_AUK_TP114_SO_0090	12
					PRAIRIE_AUK_TP120A_SO_0100	20
					PRAIRIE_AUK_TP123_SO_0060	0.71
					PRAIRIE_AUK_TP128_SO_0090	0.04
					PRAIRIE_AUK_TP136_SO_0080	2.8
					PRAIRIE_AUK_TP140_SO_0100	4.4
					PRAIRIE_AUK_TP141_SO_0200	0.5
					PRAIRIE_AUK_TP144_SO_0080	35
					PRAIRIE_AUK_TP145_SO_0160	3.7
					PRAIRIE_AUK_TP163_SO_0120	1.6
					PRAIRIE_AUK_TP170_SO_0100	0.19
					PRAIRIE_AUK_TP175_SO_0080	27
					PRAIRIE_AUK_TP181_SO_0060	8.1
					PRAIRIE_AUK_TP182_SO_0090	2.4
					PRAIRIE_AUK_TP194_SO_0140	24
					PRAIRIE_AUK_TP196_SO_0140	27
					PRAIRIE_AUK_TP201_SO_0360	0.03
Benzo(k)fluoranthene	µg/l	22/24	EQS and DWS	0.017 and 0.025	PRAIRIE_AUK_TP103_SO_0100	57
					PRAIRIE_AUK_TP108_SO_0200	0.23
					PRAIRIE_AUK_TP110_SO_0100	4.3
					PRAIRIE_AUK_TP112_SO_0210	0.16
					PRAIRIE_AUK_TP114_SO_0090	4.6
					PRAIRIE_AUK_TP120A_SO_0100	11
					PRAIRIE_AUK_TP123_SO_0060	0.29
					PRAIRIE_AUK_TP136_SO_0080	0.99
					PRAIRIE_AUK_TP140_SO_0100	1.9
					PRAIRIE_AUK_TP141_SO_0200	0.2
					PRAIRIE_AUK_TP144_SO_0080	11
					PRAIRIE_AUK_TP145_SO_0160	1.3
					PRAIRIE_AUK_TP170_SO_0100	0.07
					PRAIRIE_AUK_TP175_SO_0080	9.7

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_TP181_SO_0060	2.8
					PRAIRIE_AUK_TP182_SO_0090	1.1
					PRAIRIE_AUK_TP194_SO_0140	10
					PRAIRIE_AUK_TP196_SO_0140	11
Benzo(a)pyrene	µg/l	24/24	EQS and DWS	0.027 0.01	PRAIRIE_AUK_TP103_SO_0100	130
					PRAIRIE_AUK_TP108_SO_0200	0.36
					PRAIRIE_AUK_TP110_SO_0100	8.5
					PRAIRIE_AUK_TP112_SO_0210	0.14
					PRAIRIE_AUK_TP114_SO_0090	8.6
					PRAIRIE_AUK_TP120A_SO_0100	14
					PRAIRIE_AUK_TP123_SO_0060	0.44
					PRAIRIE_AUK_TP128_SO_0090	0.02
					PRAIRIE_AUK_TP136_SO_0080	1.7
					PRAIRIE_AUK_TP140_SO_0100	2.9
					PRAIRIE_AUK_TP141_SO_0200	0.31
					PRAIRIE_AUK_TP144_SO_0080	21
					PRAIRIE_AUK_TP145_SO_0160	2.2
					PRAIRIE_AUK_TP170_SO_0100	0.11
					PRAIRIE_AUK_TP175_SO_0080	19
					PRAIRIE_AUK_TP181_SO_0060	4.4
					PRAIRIE_AUK_TP182_SO_0090	1.3
					PRAIRIE_AUK_TP194_SO_0140	19
					PRAIRIE_AUK_TP196_SO_0140	18
					PRAIRIE_AUK_TP201_SO_0360	0.02
Indeno(1,2,3-c,d)pyrene	µg/l	23/24	DWS	0.025	PRAIRIE_AUK_TP103_SO_0100	210
					PRAIRIE_AUK_TP108_SO_0200	0.33
					PRAIRIE_AUK_TP110_SO_0100	4
					PRAIRIE_AUK_TP112_SO_0210	0.22
					PRAIRIE_AUK_TP114_SO_0090	5.7
					PRAIRIE_AUK_TP120A_SO_0100	16
					PRAIRIE_AUK_TP123_SO_0060	0.59
					PRAIRIE_AUK_TP128_SO_0090	0.04
					PRAIRIE_AUK_TP136_SO_0080	1.6
					PRAIRIE_AUK_TP140_SO_0100	4
					PRAIRIE_AUK_TP141_SO_0200	0.33
					PRAIRIE_AUK_TP144_SO_0080	22

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_TP145_SO_0160	2.2
					PRAIRIE_AUK_TP170_SO_0100	0.17
					PRAIRIE_AUK_TP175_SO_0080	15
					PRAIRIE_AUK_TP181_SO_0060	7.1
					PRAIRIE_AUK_TP194_SO_0140	15
					PRAIRIE_AUK_TP196_SO_0140	17
Benzo(g,h,i)perylene	µg/l	24/24	EQS and DWS	0.00082 and 0.025	PRAIRIE_AUK_TP103_SO_0100	400
					PRAIRIE_AUK_TP108_SO_0200	0.27
					PRAIRIE_AUK_TP110_SO_0100	5
					PRAIRIE_AUK_TP112_SO_0210	0.18
					PRAIRIE_AUK_TP114_SO_0090	5.6
					PRAIRIE_AUK_TP120A_SO_0100	16
					PRAIRIE_AUK_TP123_SO_0060	0.58
					PRAIRIE_AUK_TP128_SO_0090	0.04
					PRAIRIE_AUK_TP136_SO_0080	1.5
					PRAIRIE_AUK_TP140_SO_0100	3.8
					PRAIRIE_AUK_TP141_SO_0200	0.35
					PRAIRIE_AUK_TP144_SO_0080	20
					PRAIRIE_AUK_TP145_SO_0160	2.9
					PRAIRIE_AUK_TP170_SO_0100	0.15
					PRAIRIE_AUK_TP175_SO_0080	9.5
					PRAIRIE_AUK_TP181_SO_0060	8
					PRAIRIE_AUK_TP194_SO_0140	12
					PRAIRIE_AUK_TP196_SO_0140	15
					PRAIRIE_AUK_TP201_SO_0360	0.02
Phenol	µg/l	2/25	EQS and DWS	7.7 7.7	PRAIRIE_AUK_TP114_SO_0090	2,600
					PRAIRIE_AUK_TP142_SO_0150	400

*MDL above the relevant WQS.

Concentrations of heavy metals, ammoniacal nitrogen, TPH, PAH and phenol were measured in excess of WQS.

As the WQS are protective of water quality at the point of contact with the receptor (the water body for EQS or the customer's tap for DWS), direct comparison with soil leachate results is a conservative assessment as it does not take into account dilution and attenuation along the pathway.

The EQS for copper, manganese, nickel and zinc are based on the bioavailable fraction which is likely to be less than the total dissolved concentrations recorded in the results. As not all of the copper, manganese, nickel and zinc are likely to be bioavailable the EQS can therefore be regarded as conservative.

4.3.3 Groundwater

Twelve groundwater samples were obtained from monitoring wells and three grab samples were collected from trial pits and a 'pond' and analysed for a range of contaminants. The boreholes screen subsurface geology as shown in the table below, grab samples from the trial pits are considered to represent perched water within the Made Ground.

Borehole	Aquifer
Prairie_AUK_BH101S	GL
Prairie_AUK_BH101D	GT
Prairie_AUK_BH102	Made Ground
Prairie_AUK_BH103	GL
Prairie_AUK_BH105	GT
Prairie_AUK_BH106	GT
Prairie_AUK_BH107	GT
Prairie_AUK_BH108S	GL
Prairie_AUK_BH104	Mercia Mudstone
Prairie_AUK_BH108D	Mercia Mudstone
Prairie_AUK_BH109	Redcar Mudstone Formation and Penarth Group
Prairie_AUK_BH110	Mercia Mudstone

Contaminant concentrations were compared to the WQS in Appendix G and exceedances are summarised below.

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
Aluminium	µg/l	3 / 12	DWS	200	PRAIRIE_AUK_BH101S PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH109	710 470 260
Barium	µg/l	1 / 12	DWS	700	PRAIRIE_AUK_BH102	1,000
Chromium	µg/l	3 / 15	DWS	50	PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH109 PRAIRIE_AUK_TP115	57 110 110
Copper	µg/l	3 / 15	EQS	3.76	PRAIRIE_AUK_BH103 PRAIRIE_AUK_SW1 PRAIRIE_AUK_TP115	4.6 4.4 11
Manganese	µg/l	11 / 12	DWS	50	PRAIRIE_AUK_BH101S	720

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_BH101D	590
					PRAIRIE_AUK_BH103	390
					PRAIRIE_AUK_BH104	440
					PRAIRIE_AUK_BH105	810
					PRAIRIE_AUK_BH106	160
					PRAIRIE_AUK_BH107	290
					PRAIRIE_AUK_BH108S	620
					PRAIRIE_AUK_BH108D	590
					PRAIRIE_AUK_BH109	85
					PRAIRIE_AUK_BH110	180
Zinc	µg/l	2 / 15	EQS	7.9	PRAIRIE_AUK_BH104	16
					PRAIRIE_AUK_TP115	86
Total Cyanide	µg/l	5 / 15	EQS	1	PRAIRIE_AUK_BH101S	54
					PRAIRIE_AUK_BH103	100
			DWS	50	PRAIRIE_AUK_BH101D	64
					PRAIRIE_AUK_TP115	71
					PRAIRIE_AUK_TP186	410
Ammoniacal Nitrogen*	µg/l	6 / 15	DWS	0.5	PRAIRIE_AUK_BH101S	0.8
					PRAIRIE_AUK_BH101D	0.82
					PRAIRIE_AUK_BH102	1
					PRAIRIE_AUK_BH106	0.98
					PRAIRIE_AUK_TP115	0.54
					PRAIRIE_AUK_TP186	5.6
Aromatic C5-C7	µg/l	2/15	EQS	8	PRAIRIE_AUK_BH109	41
			DWS	1	PRAIRIE_AUK_TP186	44
Xylenes	µg/l	1/12	EQS	30	PRAIRIE_AUK_BH109	107
TPH	µg/l	5/15	EQS	50	PRAIRIE_AUK_BH101S	40
					PRAIRIE_AUK_BH104	31
			DWS	10	PRAIRIE_AUK_BH109	9,400
					PRAIRIE_AUK_TP115	180
					PRAIRIE_AUK_TP186	7,800
Naphthalene	µg/l	4/15	EQS	2	PRAIRIE_AUK_BH102	3.7
					PRAIRIE_AUK_BH104	4.3
			DWS	2	PRAIRIE_AUK_BH109	4,900

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_TP186	690
Benzo(b)fluoranthene	µg/l	11 / 15	DWS EQS	0.025 0.017	PRAIRIE_AUK_BH101S PRAIRIE_AUK_BH101D PRAIRIE_AUK_BH102 PRAIRIE_AUK_BH103 PRAIRIE_AUK_BH104 PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH108D PRAIRIE_AUK_BH109 PRAIRIE_AUK_SW1 PRAIRIE_AUK_TP115 PRAIRIE_AUK_TP186	0.09 0.03 0.03 0.24 0.4 0.04 0.02 5.8 0.44 0.83 4.5
Benzo(k)fluoranthene	µg/l	7/15	DWS EQS	0.025 0.017	PRAIRIE_AUK_BH101S PRAIRIE_AUK_BH103 PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH109 PRAIRIE_AUK_SW1 PRAIRIE_AUK_TP115 PRAIRIE_AUK_TP186	0.02 0.06 0.02 2.6 0.15 0.3 1.5
Benzo(a)pyrene	µg/l	10/15	EQS and DWS	0.027 0.01	PRAIRIE_AUK_BH101S PRAIRIE_AUK_BH101D PRAIRIE_AUK_BH102 PRAIRIE_AUK_BH103 PRAIRIE_AUK_BH104 PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH109 PRAIRIE_AUK_SW1 PRAIRIE_AUK_TP115 PRAIRIE_AUK_TP186	0.05 0.02 0.02 0.12 0.22 0.02 2.8 0.22 0.56 2.4
Indeno(1,2,3-c,d)pyrene	µg/l	9/15	DWS	0.025	PRAIRIE_AUK_BH101S PRAIRIE_AUK_BH101D PRAIRIE_AUK_BH103 PRAIRIE_AUK_BH104 PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH109	0.06 0.03 0.21 0.32 0.04 2.6

Contaminant	Unit	No. Samples Exceeding	WQS Exceeded		Sample	Concentration (µg/l)
					PRAIRIE_AUK_SW1	0.14
					PRAIRIE_AUK_TP115	0.38
					PRAIRIE_AUK_TP186	1.2
Benzo(g,h,i)perylene	µg/l	10/15	EQS DWS	0.00082 0.025	PRAIRIE_AUK_BH101S PRAIRIE_AUK_BH101D PRAIRIE_AUK_BH102 PRAIRIE_AUK_BH104 PRAIRIE_AUK_BH106 PRAIRIE_AUK_BH108D PRAIRIE_AUK_BH109 PRAIRIE_AUK_SW1 PRAIRIE_AUK_TP115 PRAIRIE_AUK_TP186	0.06 0.03 0.02 0.3 0.05 0.03 2.6 0.2 0.52 1.6
Phenol	µg/l	1/15	EQS DWS	7.7 7.7	PRAIRIE_AUK_TP186	3,400
1,2-dichloroethane	µg/l	1/15	DWS	3	PRAIRIE_AUK_BH109	7

* DWS for Ammoniacal Nitrogen is for Ammonium as NH_4.

Concentrations of manganese and PAHs have been measured in excess of WQS in more than half of the water samples collected from the site. Concentrations of other heavy metals, ammoniacal nitrogen, total cyanide, TPH, xylenes, phenol and 1,2-dichoroethane were also measured in excess of WQS.

It is noted that the groundwater pH in the Made Ground is alkaline (pH 12.5) and the pH of the groundwater is closer to neutral in the superficial deposits and bedrock ranging from pH 7.4 to 9.2.

4.3.4 Qualitative Risk Assessment for Substances in Leachate/Groundwater without WQS

As shown in Appendix G, for several contaminants including some metals (beryllium) and VOCs, WQS are not readily available for comparison. Concentrations of beryllium were not measured above the laboratory MDL in any of the leachate or groundwater samples, where tested. As such, this compound is not considered to pose a significant risk to identified water resource receptors. Likewise, where concentrations of VOC were measured below MDL in the groundwater samples, these contaminants are not considered to represent a risk to water resources.

The following compounds did not have readily available GAC and were recorded at concentrations in excess of their MDL: magnesium, sulphate, sulphur, chloride, free cyanide, thiocyanate, selected PAHs, styrene, isopropylbenzene, 2-chlorotoluene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,2-dibromo-3-chloropropane.

Four of the compounds, magnesium, sulphate, sulphur and chloride are present naturally in groundwater. Considering the site setting (close to saline coastal environment) these compounds are not considered to pose a significant risk to water resources and will not be assessed further.

Given a number of PAHs do not have readily available WQS, assessment of the risk to water resources will be made using PAHs in groundwater that have available WQS. This is considered to be sufficiently protective of water resources.

Further assessment of the remaining contaminants for which no available GAC has been identified will be considered in Section 4.3.5.

4.3.5 Discussion

Generally, the highest concentrations of heavy metals and inorganics were measured in monitoring wells screening the Made Ground and the superficial deposits. The highest concentrations of TPH, PAH and VOCs were generally measured in BH109 which screens the Redcar Mudstone Formation with the highest concentration of chromium also measured in groundwater sampled from this location. Given the distribution of the contaminants throughout the water column, and that contaminants of concern have been measured in excess of the GAC for the protection of water resources, further assessment is needed.

Further consideration of the risk to water resources from contaminants for which a WQS has not been identified including free cyanide, thiocyanate, styrene, isopropylbenzene, 2-chlorotoluene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene and 1,2-diromo-3-chloropropane is also warranted.

4.4 Built Receptors

Significant contamination can pose a risk to subsurface structures and services, where these are in direct contact with soil and/or groundwater. Substances such as dissolved metals, cations, phenols and hydrocarbons in high concentrations can adversely affect in-ground materials such as concrete, metal and plastics.

The most sensitive built receptor is generally plastic water supply pipes, which can be affected by permeation of hydrocarbons and organic solvents into the pipe. The available chemical data for soil samples has been reviewed against the UK Water Industry Research (UKWIR) criteria to provide an indication of the potential acceptability of polyethylene (PE) pipes in brownfield land (Water UK, 2014), although an exact comparison is not possible due to differences in the determinand suites tested.

Concentrations of petroleum hydrocarbons, phenol, VOC or SVOC measured in soil samples are above the criteria for unprotected PE water pipes with between 8% (phenol) and 47.6% (SVOCs) of soil samples in excess of UKWIR criteria. Therefore, additional testing should be carried along the route of any proposed new water supply pipe, or barrier pipe or similar could be used.

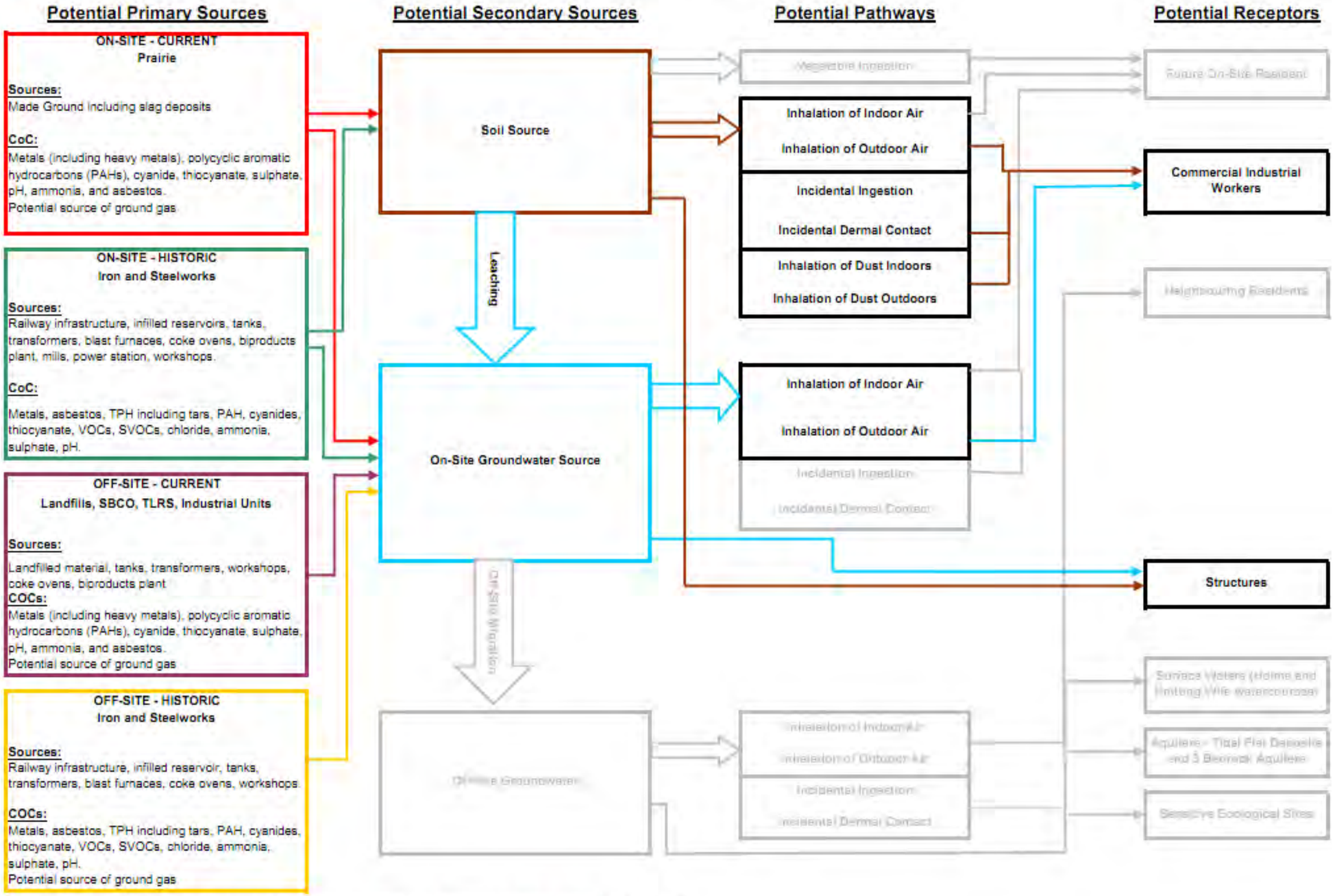
The potential for the ground conditions to generate an aggressive chemical environment for concrete (sulphate attack) is outside the scope of this report.

Potential pollutant linkage E (attack on subsurface structures) cannot be discounted at this stage and appropriate mitigation measures may be required.

5 Updated Conceptual Site Model

An updated CSM has been developed, using the findings of the above assessments, and is presented below as Figure 16. Pollutant linkages that have been shown to be inactive or not a significant risk have been removed.

Figure 16
Outline Conceptual Site Model - Commercial Industrial End Use



6 Conclusions

This report has used information obtained from the recent ground investigation to assess the potential contamination risks to human health, ecological receptors, built property and Controlled Waters. It was assumed that the site will be redeveloped as commercial or industrial properties. Based upon this assessment of data, the CSM has been updated to identify the potential pollutant linkages considered to be complete.

6.1 Human Health Risk

Potential risks to human health from a range of contaminants measured in shallow soils (Made Ground including slag materials) and groundwater were assessed using GAC. Concentrations of arsenic and PAHs were measured in excess of the GAC in soil and the risk to human health from concentrations of total cyanide via the direct contact and dust inhalation pathways could not be ruled out. Additionally the risk to human health from concentrations of naphthalene and free cyanide via the vapour inhalation pathway require further assessment. Concentrations of contaminants were not measured above the GAC derived for the protection of human health in groundwater.

Concentrations of arsenic, total cyanide and PAHs will need to be considered in the remedial strategy for the site. Based on the information currently available, further assessment of the vapour inhalation pathway is required to consider the risk to human health from concentrations of naphthalene and free cyanide.

NAPL and tar has been identified primarily within the Made Ground and associated with subsurface or former above ground structures and plants. Further consideration of the NAPL with respect to the risk to human health will be needed as part of the remedial strategy.

Asbestos was recorded in approximately 1/3 samples of Made Ground across the site, of these approximately ½ were quantified at <0.001% but the remainder were quantified to 0.02 % by mass. Asbestos in shallow soils in areas without buildings or hardstanding has the potential to become airborne and available for inhalation, particularly during construction, posing chronic risks to human health.

Additional assessment may be required dependent on the redevelopment scenario to further delineate the asbestos impact on the site and determine necessary mitigation measures. It is likely that a clean cover system in areas of soft landscaping can be utilised to mitigate the risk to site occupiers and neighbouring land users. During redevelopment, good construction practice such as minimising handling of asbestos-contaminated soils, damping down and appropriate Personal Protective Equipment (PPE) may be sufficient to mitigate the risk to construction workers, but the works should be carried out with due consideration to the Control of Asbestos Regulations (2012).

Soil containing more than 0.1% m/m asbestos, if disposed of off-site, may be classified as hazardous waste and attract significantly higher disposal costs. Additional testing would be required to confirm the quantity of asbestos and delineate any areas above the threshold.

6.2 Controlled Waters

Exceedances of Water Quality Standards (WQS) were recorded in soil leachate samples and groundwater samples from the Made Ground, superficial deposits and the bedrock. Dissolved contaminants in groundwater are generally consistent with soil and soil leachate analysis results indicating that some leaching is occurring into shallow groundwater from the slag deposits and hydrocarbon impacts on the site.

Further assessment of the risk to water resources is warranted based on the concentrations of contaminants measured in leachate and groundwater and the presence of NAPL and tar.

6.3 Recommendations

1. DQRA be undertaken as a higher tier assessment to further characterise pollutant linkages at the Site using site-specific information and derive site-specific assessment criteria for the assessment of the risk to human health and water resources.
2. Prior to redevelopment a remediation options appraisal [in press] should be carried out for the loose asbestos fibres identified in the Made Ground and for soils containing CoC in excess of screening

criteria. Additional data collection may be needed to support the associated risk assessment/remediation design.

3. Depending on the redevelopment scenario further ground investigation including ground gas monitoring of shallow soils should carried out prior to redevelopment to quantify the ground gas risk on the site in the context of the proposed layout and design.
4. 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.

APPENDIX A

Figures

Legend

Site Boundary

Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

N

Title: Prairie - Site Location Plan

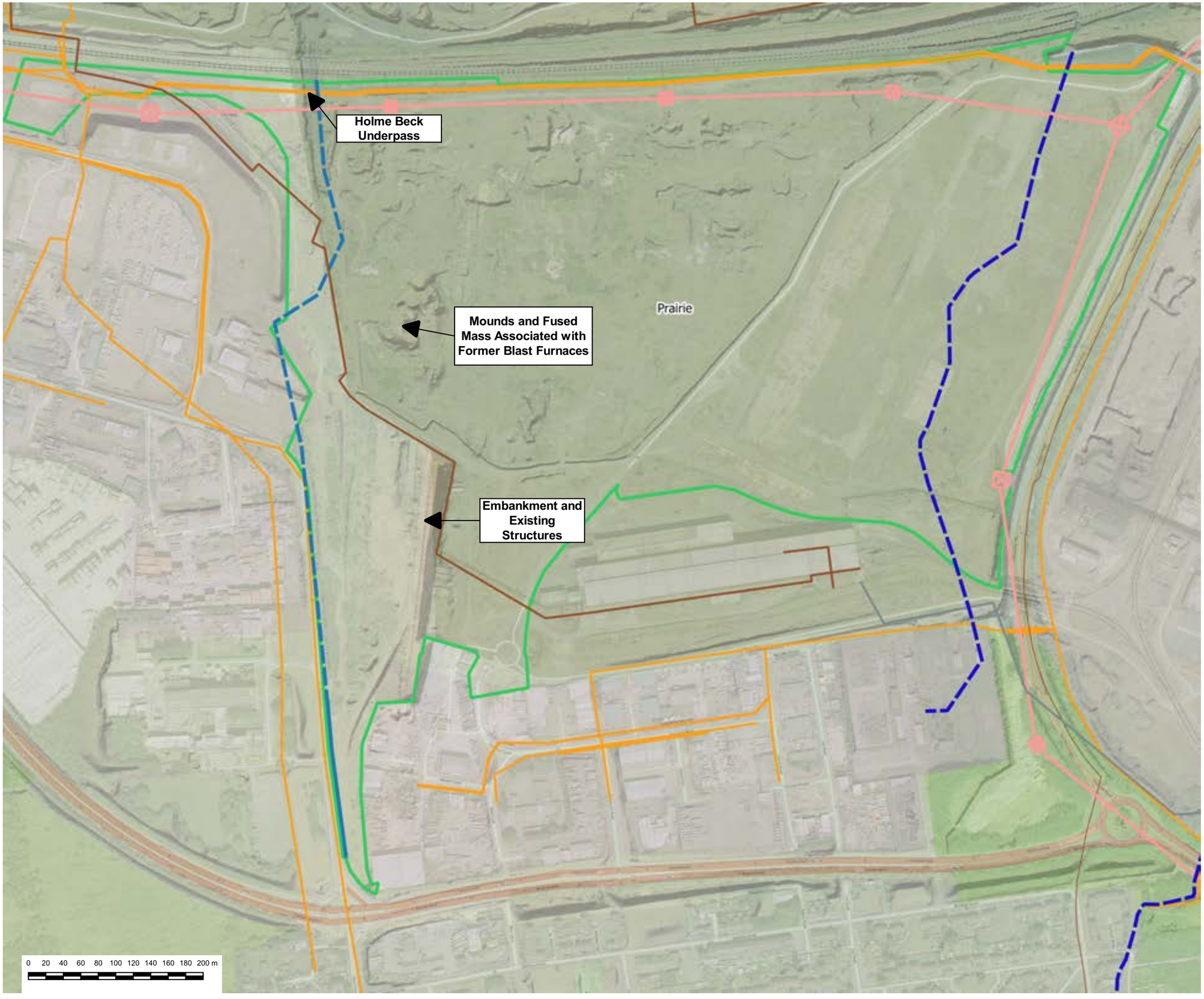
Site: Redcar Steelworks (Prairie)

Client:
South Tees Developement Corporation

Project: 10035117	**Figure 1**

Date: 05/06/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0063-01-Prarie_SLP

ARCADIS



Legend

STDC Shapefiles

- Knitting Wife Beck

STDC data

Holme Beck

- Holme Beck
- Holme Beck Culvert
- Sewers
- Layer_MGT 275KV Cable
- Layer_Existing National Grid Elec
- Layer__CokeOvenGasUnderground
- Layer__CokeOvenGasAboveGround

Site Plans

Redline

- Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

The accuracy of non-Arcadis data has not been verified.

Holme Beck route added by Arcadis based on historical site plans, accuracy has not been confirmed.

N

Title:
Prairie - Site Setting and Layout

Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: 10035117	**Figure 2**

Date: 15/05/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0065-01-Prairie_Sett

ARCADIS

Legend

Site Boundary

Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

N

Title: Prairie - Layout circa 1960

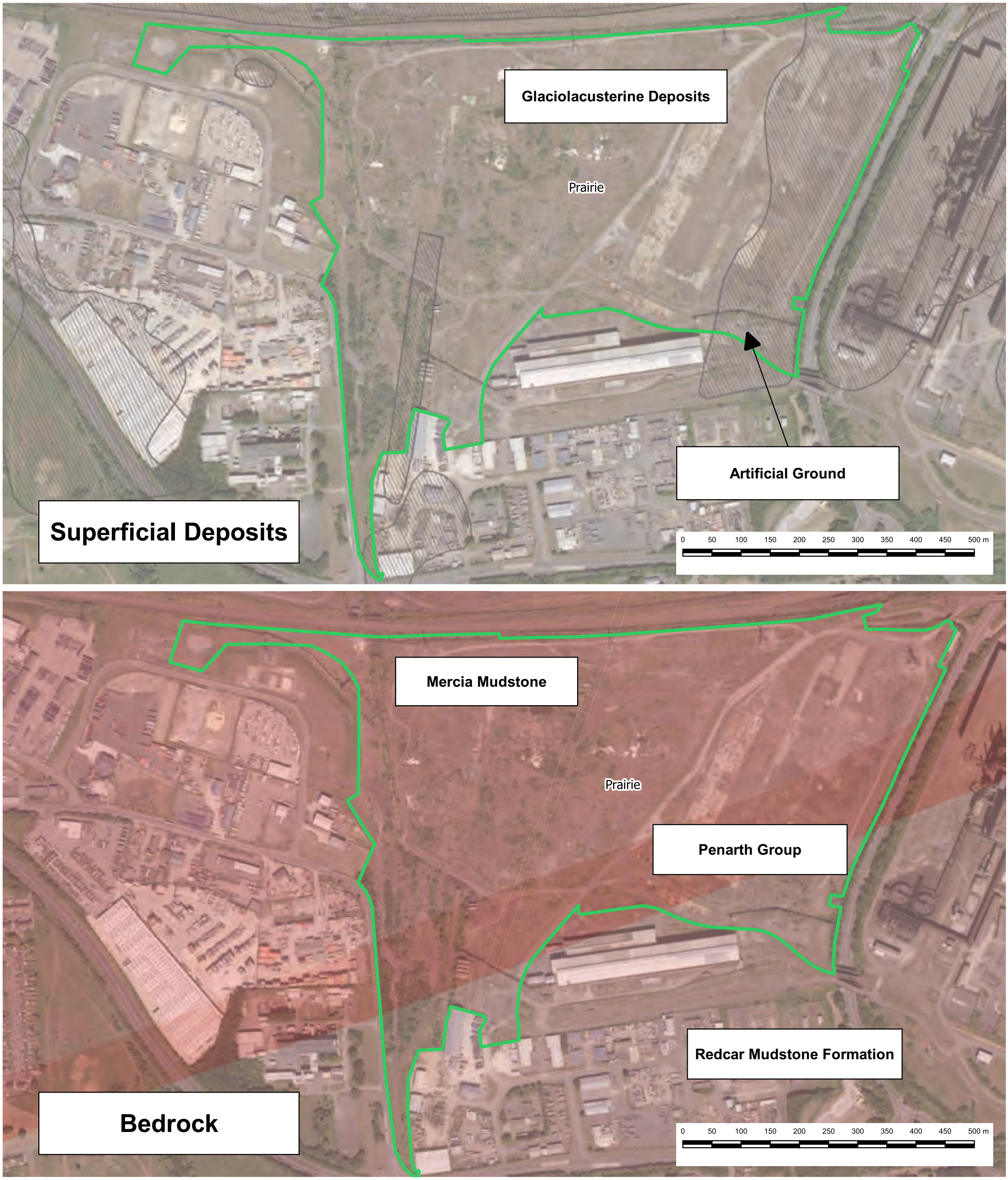
Site:
Redcar Steelworks

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 3

Date: 12/06/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0082-01-Prairie_1960

ARCADIS



Legend

Site Boundary

Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

Title: Prairie - Anticipated Geology

Site:
Redcar Steelworks - Prairie

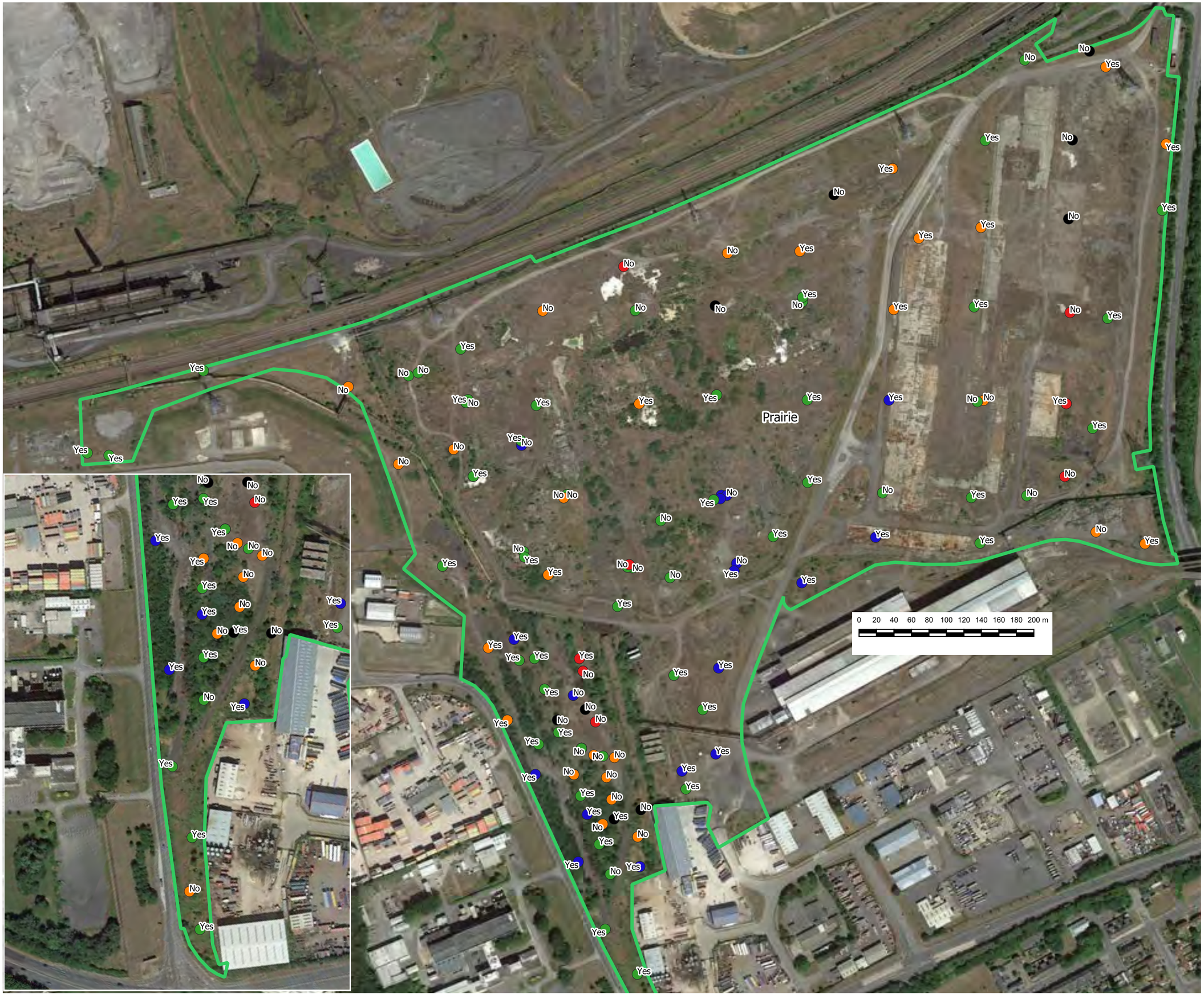
Client:
South Tees Developement Corporation

Project:
10035117

Figure 4

Date: 15/05/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0064-01-Prairie_Geo

ARCADIS



Legend

Made Ground Depth

Yes/No = Base of Made Ground Proven

- Less than 1m
- 1.0 to 2.0
- 2 to 3m bgl
- 3 to 4m
- Greater than 4m

Site Boundary

- Prairie

N

Title: Prairie - Made Ground Thickness Identified

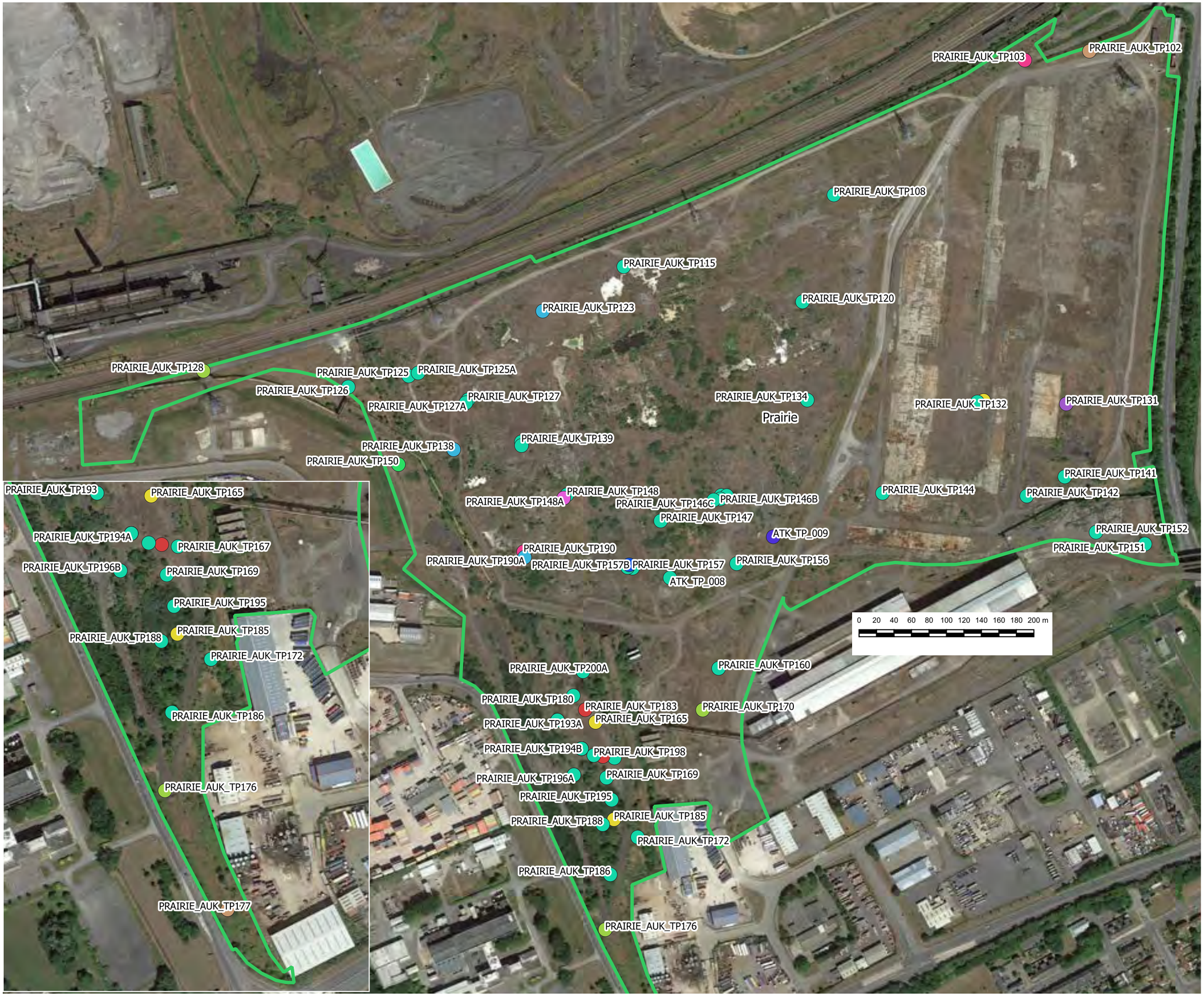
Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 5

Date: 04/06/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0067-02-Prairie_MG_Thkns

ARCADIS



Legend

Obstruction Type

- Brick Foundations
- Concrete and Brick Foundations
- Concrete Boulders
- Concrete Foundatiosn and Metal
- Concrete Foundations
- Concrete Foundations and Slag
- Foundations and voids
- Fused slag
- Metal pipe
- Possible service
- Railway track
- Slag boulders

Site Plans

Site Boundary

- Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

N

Title: Prairie - Obstructions Identified

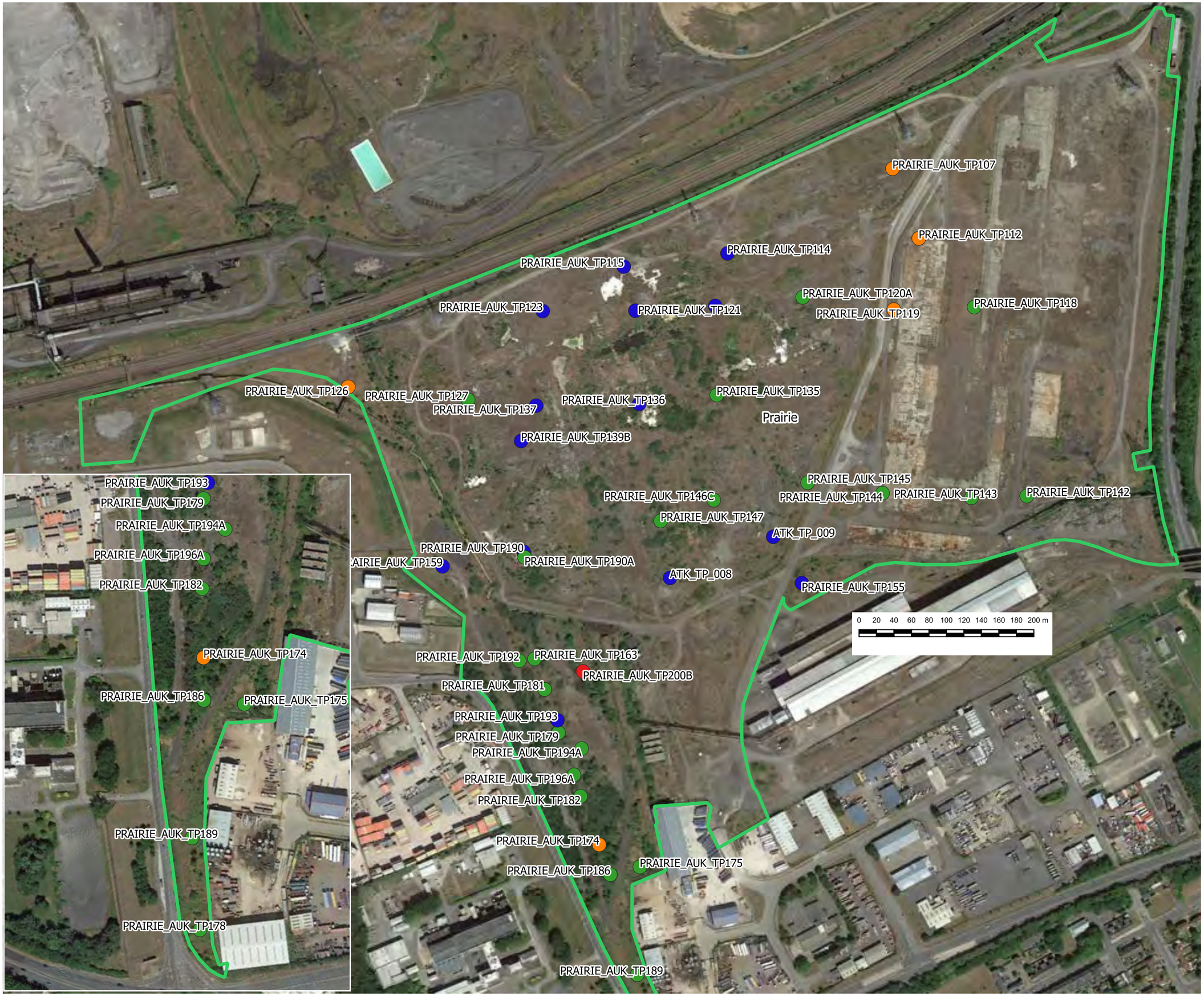
Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 6

Date: 19/05/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0069-02-Prairie_Obstn

ARCADIS



Legend

Strike Depth

- Less than 1m
- 1.0 to 2.0
- 2 to 3m bgl
- 3 to 4m

Site Boundary

- Prairie

Title: Prairie - Groundwater Identified in Trial Pits

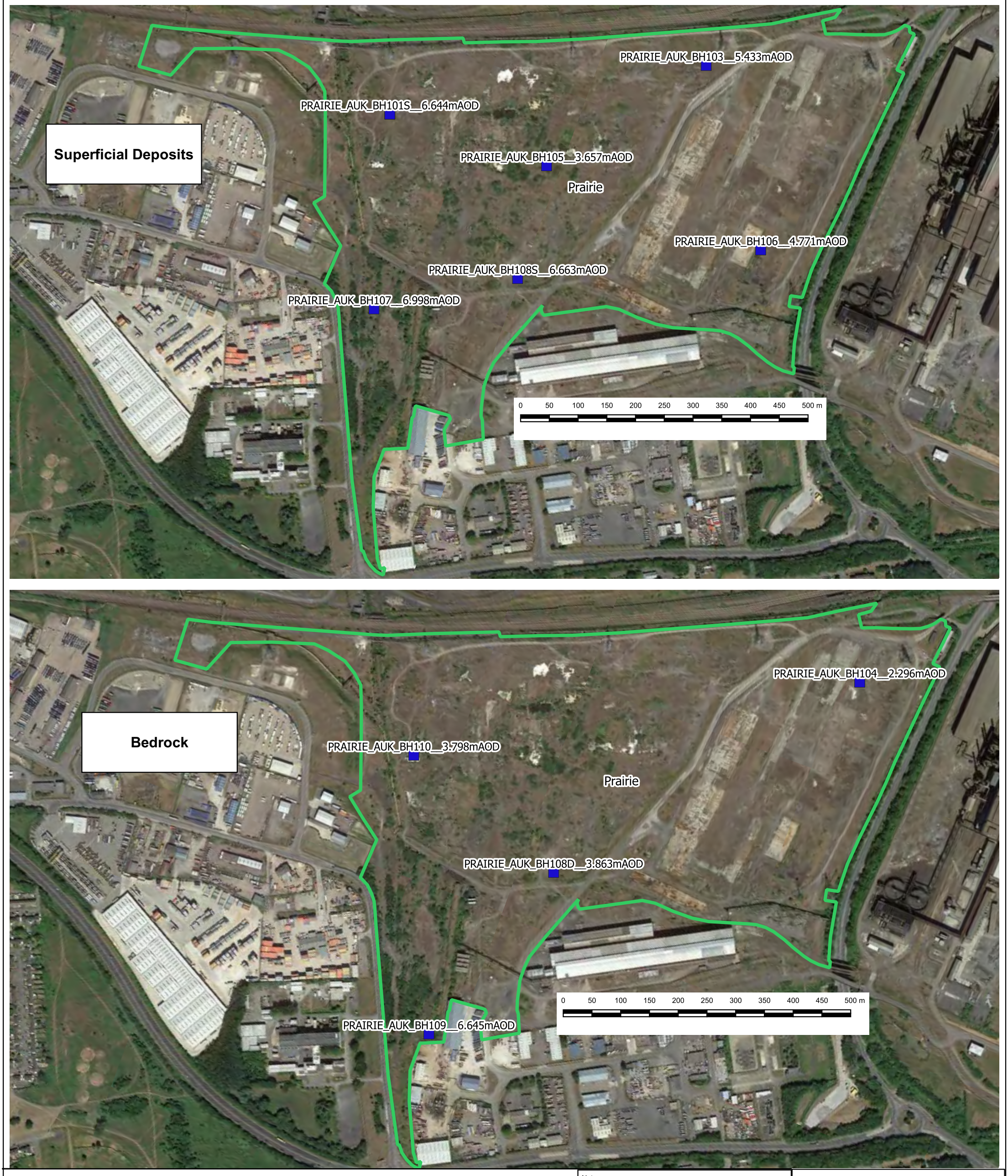
Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 7

Date: 19/05/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0070-02-Prairie_GW_MG

ARCADIS



Legend

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

Title: Groundwater Elevations

Site:
Redcar Steelworks - Prairie

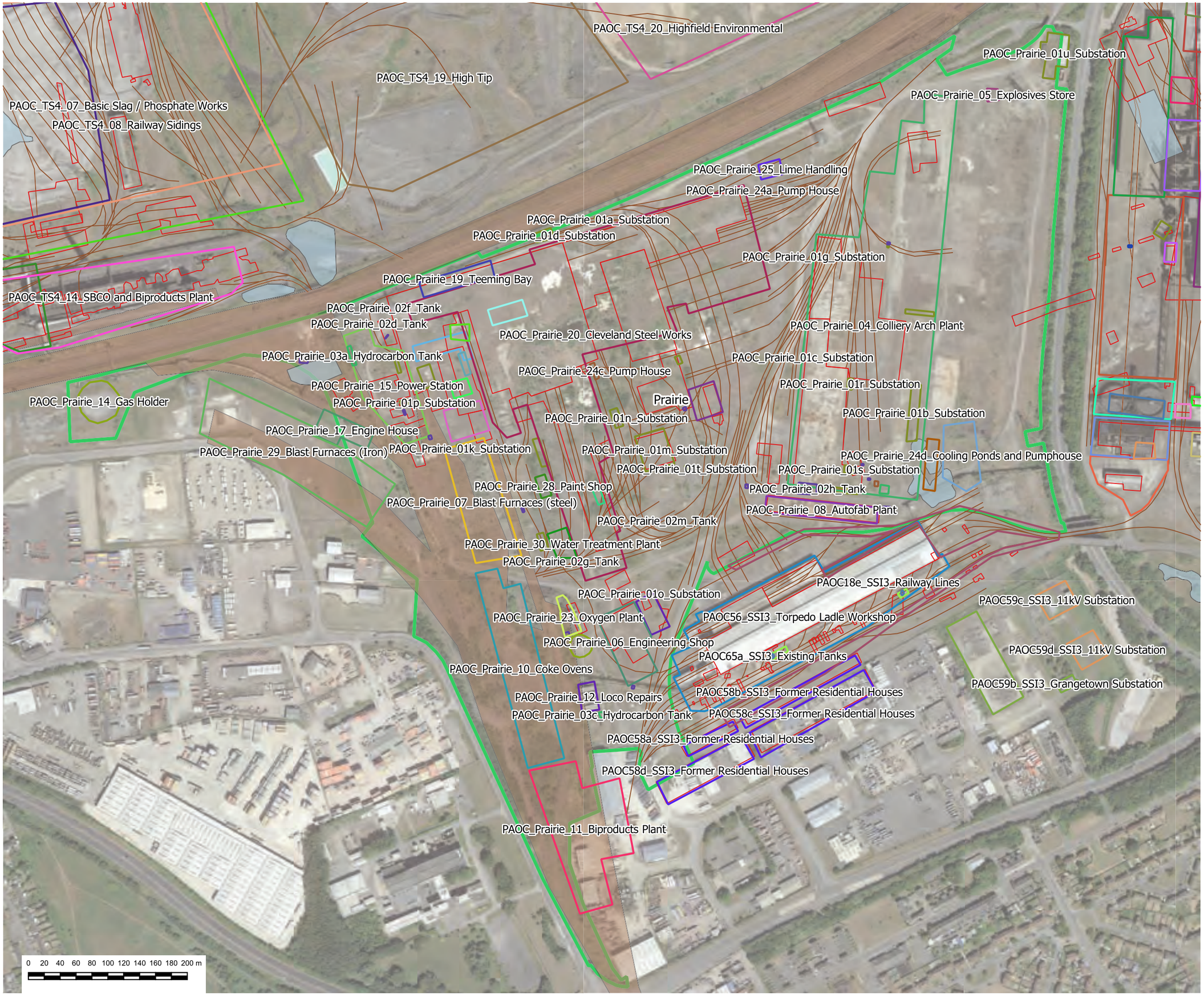
Client:
South Tees Developement Corporation

Project:
10035117

Figure 8

Date: 12/06/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0083-01-Prairie_GWE

ARCADIS



Legend

STDC Shapefiles

- Rail
- Rail_areas
- Ponds
- Buildings

Site Boundary

- Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

N

Title: Prairie - Selected Potential Areas of Concern

Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project:
10035117

Figure 9

Date: 19/05/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0071-01-Prairie_PAOC

ARCADIS

Legend

Arcadis Investigations

- NAPL
- Sheen / Seepage
- Sheen
- Tar

Historic Locations

- NAPL
- NAPL / Tar

Redline

- Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

NAPL: Non-aqueous Phase Liquid

Arcadis cannot warrent the accuracy of third party data.

N

Title: Prairie - Locations Where NAPL Identified

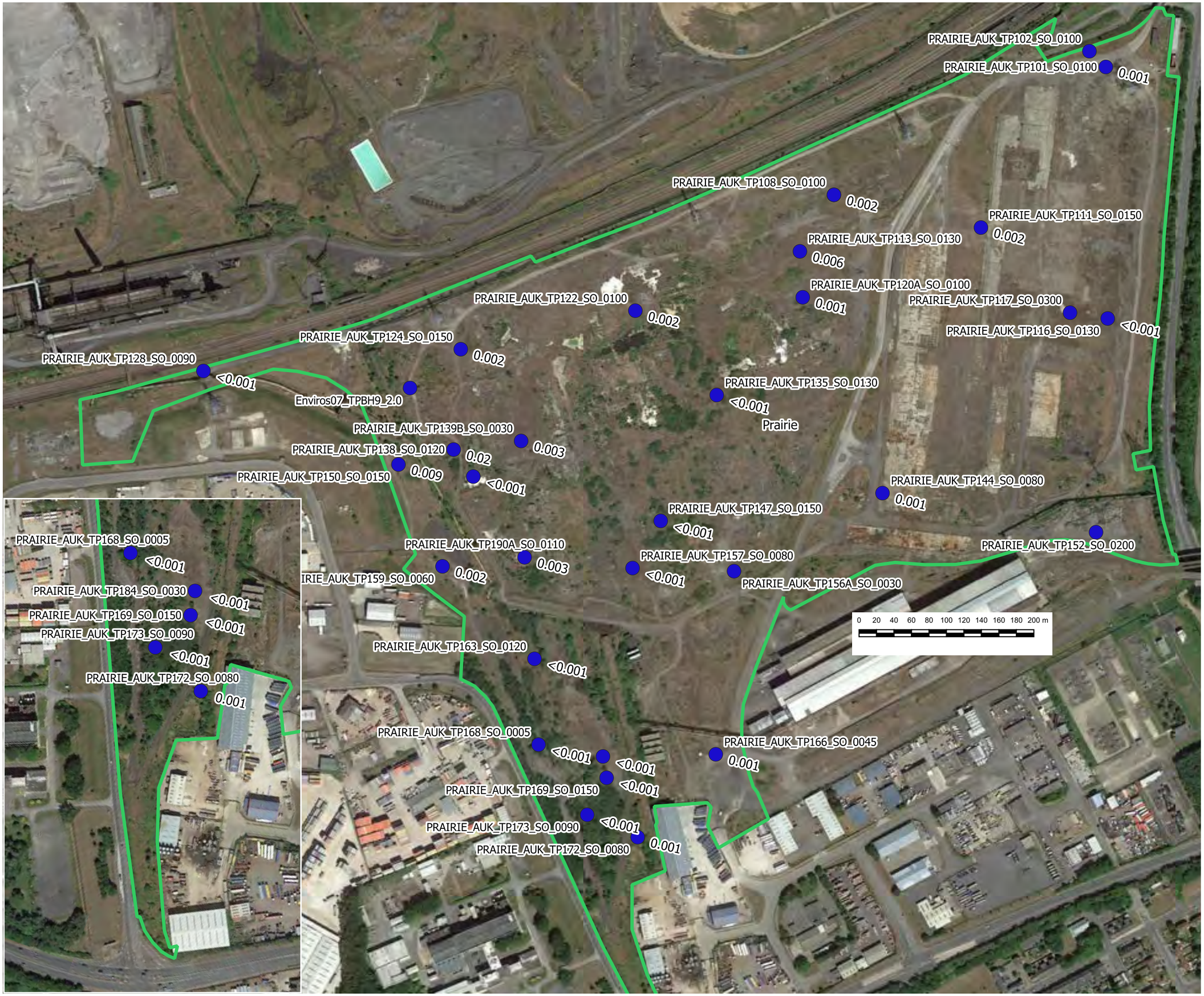
Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 10

Date: 03/10/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0079-01-Prairie_NAPL

ARCADIS



Legend

Asbestos Detected

- Yes

Site Boundary

- Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

Label: SampleID and Percentage Quantification

Title: Prairie - Asbestos Testing Results (Presence and Quantification)

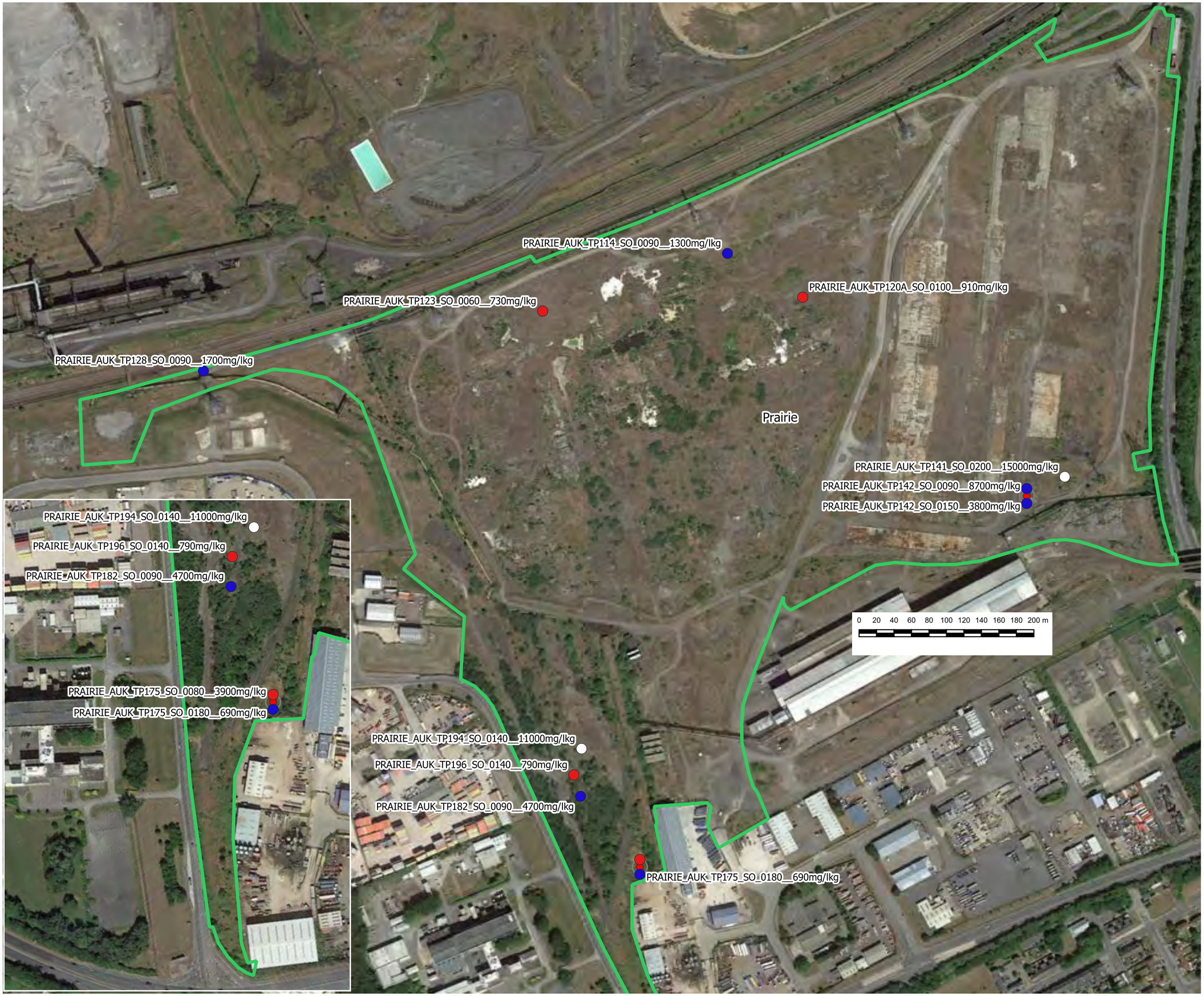
Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 11

Date: 04/06/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0080-02-Prairie_Asbestos

ARCADIS



Legend

Concentration

- >/10,000mg/kg
- 1,000 to <10,000mg/kg
- 500 to <1,000mg/kg

Site Boundary

- Prairie

Notes:

CONTACT ARCADIS IN CASE OF ANY QUERIES.

Label: LocationID_Concentration

Title: Prairie - Total Petroleum Hydrocarbons Measured Above 500 mg/kg (Arcadis Data)

Site: Redcar Steelworks - Prairie

Client:
South Tees Developement Corporation

Project: **10035117**	Figure 12

Date: 22/05/2020
Drawn By: JALM
DRG No: 10035117-AUK-XX-XX-DR-ZZ-0077-01-Prairie _TPH

ARCADIS