Net Zero Teesworks Flood Risk Assessment

Final Report

December 2021

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Revision History

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P01 / 29 November 2021	Draft report	John McNicholas and Lichfields
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Contract

This report describes work commissioned by Anthony Greally, on behalf of Teesworks, during a project teleconference on 2 November 2021. Teesworks's representative for the contract was Anthony Greally of Lichfields. Alice Gent and Eleanor Williams carried out this work.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to South Tees Site Company.

Acknowledgements

JBA wishes to thank Redcar and Cleveland Council and the Environment Agency for supply for flood history records.

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Abbreviations

AEP	Annual Exceedance Probability
ALTBAR	Mean catchment altitude (m above sea level)
ASCII	American standard character set for information interchange
BFIHOST	Base Flow Index estimated from soil type
BGS	British Geological Survey
DEFRA	Department of the Environment, Food and Rural Affairs (formerly MAFF)
DPLBAR	Index describing catchment size and drainage path configuration
DPSBAR	FEH index of mean drainage path slope
DTM	Digital Terrain Model
EA	Environment Agency
EIA	Environmental Impact Assessment
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
LiDAR	Light Detection And Ranging
m AOD	metres Above Ordnance Datum
NGR	National Grid Reference
NPPF	National Planning Policy Framework
OS	Ordnance Survey
OS NGR	Ordnance Survey National Grid Reference
PDF	Portable Document Format
PPG	Planning Policy Guidance
PROPWET	FEH index of proportion of time that soil is wet
Ramsar	The intergovernmental Convention on Wetlands, signed in Ramsar, Iran, in 1971
SAAR	Standard Average Annual Rainfall (mm)
SFRA	Strategic Flood Risk Assessment
SPRHOST	Standard percentage runoff estimated from soil type
SSSI	Site of Special Scientific Interest

Definitions

FARL	Flood Attenuation by Reservoirs or Lakes. This provides a guide to the degree of flood attenuation by reservoirs or lakes in the catchment which will have effect on flood response. A value of 1 indicates no attenuation, whereas 0.8 and under indicates substantial attenuation.

1 Introduction

1.1 Scope of Works

Teesworks commissioned JBA Consulting in November 2021 to prepare a high level Flood Risk Assessment (FRA) to accompany the planning application for the remediation of the site proposed for the Net Zero Teesworks (NZT) area of the wider Teesworks site on the south bank of the River Tees, near Redcar.

A separate Development Consent Order application has been submitted to the Planning Inspectorate for the overall NZT development.

This high level Flood Risk Assessment (FRA) study has been undertaken to meet the requirements of the National Planning Policy Framework[1] (NPPF) and to support the remediation planning application in relation to assessing flood risk. It will include reference to documentation submitted for the DCO as well as previous reports conducted for the Teesworks site.

This FRA will comprise the following:

- Data review – including:
  - Review of Phase 1 Data Collection and Baseline Assessment report for the wider Teesworks development.
  - Review of baseline risk for water management and flooding and assess the impacts of the proposed development undertaken for the Level 2 Strategic Flood Risk Assessment (SFRA).
  - Review of the water management chapter of the environmental assessment for the DCO application.
  - Review of requests for flood records from Redcar and Cleveland Council and the Environment Agency, undertaken for the Level 2 (SFRA) and the water management chapter of the environmental assessment for the DCO application.
- Assess impacts of proposed development
- Identify appropriate mitigation and enhancement measures

1.2 Reporting Guidelines and Legislation Context

This Flood Risk Assessment (FRA) is consistent with the reporting requirements detailed within the National Planning Policy Framework (NPPF).

The aim of this FRA is to present relevant information pertaining to flooding in a clear format that can be reviewed by the Planning Authority and the Environment Agency. It does not guarantee that the proposed remediation works as part of the development will be acceptable to the Planning Authority and the Environment Agency in terms of flood risk and water management.

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1 NPPF https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Accessed November 2021]

2 Flood Risk Assessment

2.1 Site Details and Location

The proposed development site is located in the wider Teesworks area – hereafter referred to as the site – and is centred at Ordnance Survey National Grid Reference OS NGR 457008 525329. The site is 70.5ha (705,021m^2) in size and is located on the River Tees estuary, approximately 3.2km to the west of Redcar.

The site is bounded by the two Teesworks sites - The Foundry site to the north west and Long Acres site to the south. Current vehicular access to the site is via Tod Point Road and former road network which currently runs through the site, predominately in a north-west south-east direction. In addition to road networks, a former transfer railway extends into the northern part of the site and the major operators freight rail line passes through the southern part of the site, which works to connect the Redcar Bulk Terminal to the north west. In relation to larger transport connections in vicinity to the site, the A1085 is located 0.73km south east of the site and the nearest railway line (the Darlington to Saltburn Railway line) is located 0.26km south east of the site.

The site is comprised of brownfield land and the site's prior land use was as a former British Steel Corporation's Iron making complex. Further details regarding the sites existing and historic land use is discussed in Section 2.2.

2.1.1 Catchment Hydrology

The site is located within the catchment of the River Tees, which flows to the west of the site. The south western section of the site lies at the edge of the catchments of two other watercourses: The Fleet and Dabholm Beck.

The Fleet, at its closest point, is located approximately 280m away from the southern site boundary. At the point where The Fleet is in closest proximity to the site, the watercourse is flowing in a south westerly direction. While The Fleet is largely mapped as an open watercourse, there are a sections which are culverted as it flows underneath railway embankments and roads. 1.4km downstream of the site The Fleet joins the Dabholm Beck.

Dabholm Beck, at its closest point, is located approximately 1.4km away from the southern site boundary. At the confluence with The Fleet, Dabholm Beck is diverted to flow from a north easterly direction to a north westerly direction as the watercourse is fed to discharge into the River Tees via Dabholm Gut (part of Dabholm Beck but is tidal in nature).

To north east of the site boundary, two drains are located within the adjacent Foundry site - the Redcar Coke Ovens Outfall pipe flows in a north westerly direction to the River Tees and the Redcar Power Station Outfall discharges into Tees Bay.

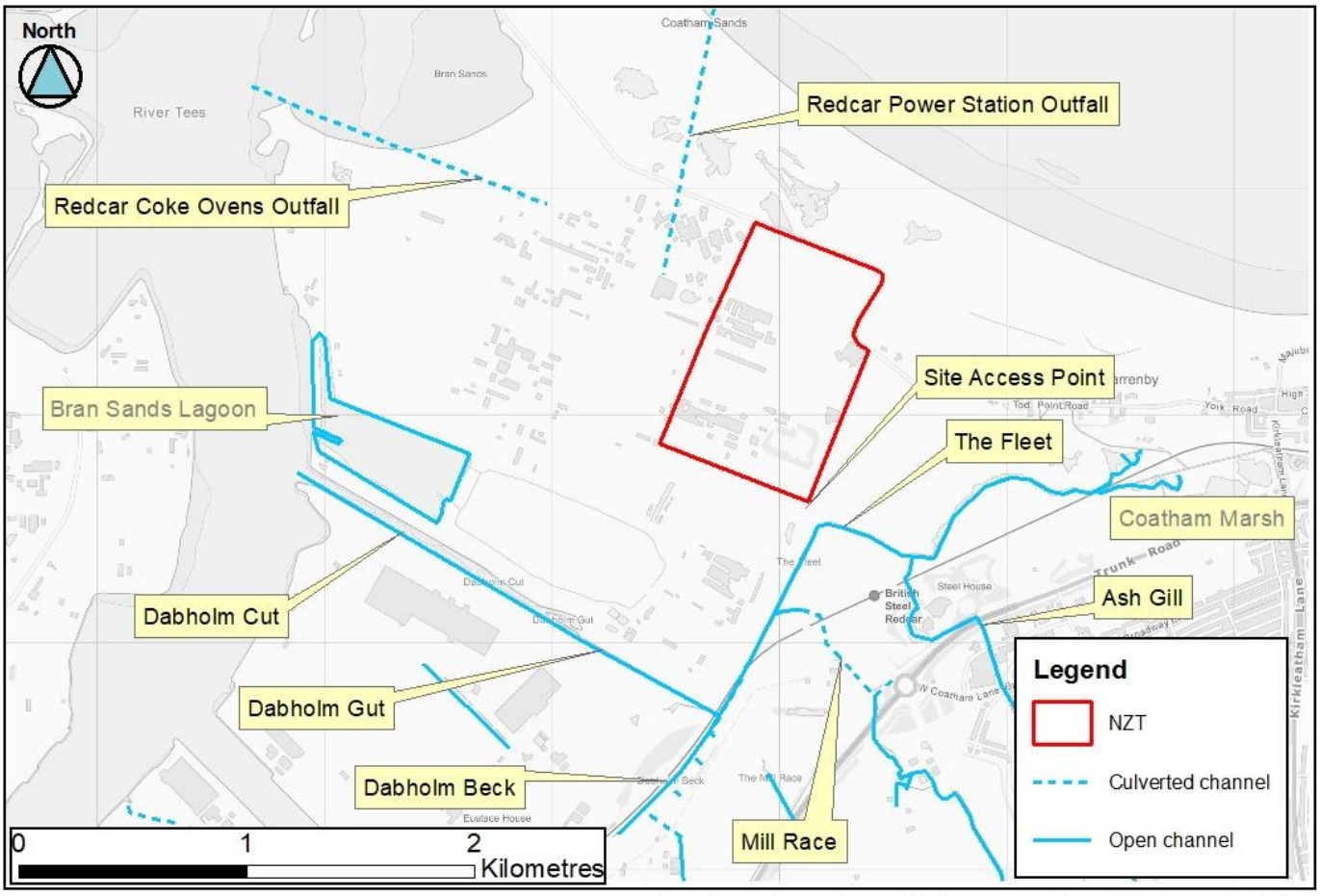

Figure 2-1: Map showing watercourses on site

The catchment of The Fleet (up to NGR: NZ 57002 24231) drains an area of 10.0km^2 in a north westerly direction. The source of the watercourse is Fleet Beck, which flows through Locke Park/Coatham Marsh to the north of Redcar. An unnamed secondary watercourse flows into The Fleet approximately 0.5km south east of the site. The catchment topography slopes from south to north, with ground levels within the catchment dropping to 3.6m AOD from an elevation of 202m AOD to the top of the catchment. The Mill Race watercourse flows into The Fleet after point NZ 57002 24231 but before the confluence with Dabholm Beck via a culvert.

The catchment of Dabholm Beck (up to NGR: NZ 56135 24005) drains an area of 20.3km^2 in a northerly direction while the channel of Dabholm Beck flows in a north easterly direction. Minor culverts drain into Dabholm Beck, likely used to drain run-off from the A1085. The catchment of Dabholm Beck includes the sub-catchment of The Fleet as well as the sub-catchments of two minor watercourses which contribute the Dabholm Beck before its confluence with The Fleet: an unnamed drainage channel and The Mill Race watercourse. The catchment topography slopes from south to north, with ground levels within the catchment dropping to 2.20m AOD from an elevation of 234m AOD to the top of the catchment.

The FARL values for both The Fleet and Dabholm Beck catchments range between 0.94-0.95 which indicates that, while there may be some reservoir influence within both catchments, the influence is not considered major. URBEXT values of 0.1-0.2 also indicates that urban

cover within the catchment is not considered extensive in hydrological terms. Both catchments are shown in Figure 2-2.

Table 2-1: Catchment descriptors for both catchments draining to the site.

Catchment Descriptor	The Fleet catchment	Dabholm Beck catchment
AREA (km^2)	10.1	20.3
ALTBAR (m above sea level)	31.0	31.0
BFIHOST	0.33	0.35
DPLBAR (km)	4.75	4.80
DPSBAR (m/km)	27.7	29.7
FARL	0.95	0.94
PROPWET	0.32	0.32
SAAR (mm)	614	615
SAAR4170 (mm)	633	630
SPRHOST (%)	38.9	38.0
URBEXT1990	0.1687	0.2374
URBEXT2000	0.1499	0.2645

The British Geological Survey[2] online viewer indicates the underlying bedrock geology comprises the Redcar Mudstone Formation with the Mercia Mudstone Group strata in the north of the site. The superficial geology comprises Made Ground underlain by glacial till and tidal flat deposits of sand and silt. These strata constitute Secondary (Undifferentiated) aquifers.

The UK Soil Observatory viewer indicates that the Soilscapes Mapping for England and Wales category for the site is for loamy and clayey soils of coastal flats with naturally high groundwater. Immediately north of the site are sand dune soils which are freely draining. To the east of the site, under Coatham Marshes, are loamy and clayey soils with impeded drainage.

2 http://mapapps,bgs.ac.uk/geologyofbritain/home.html

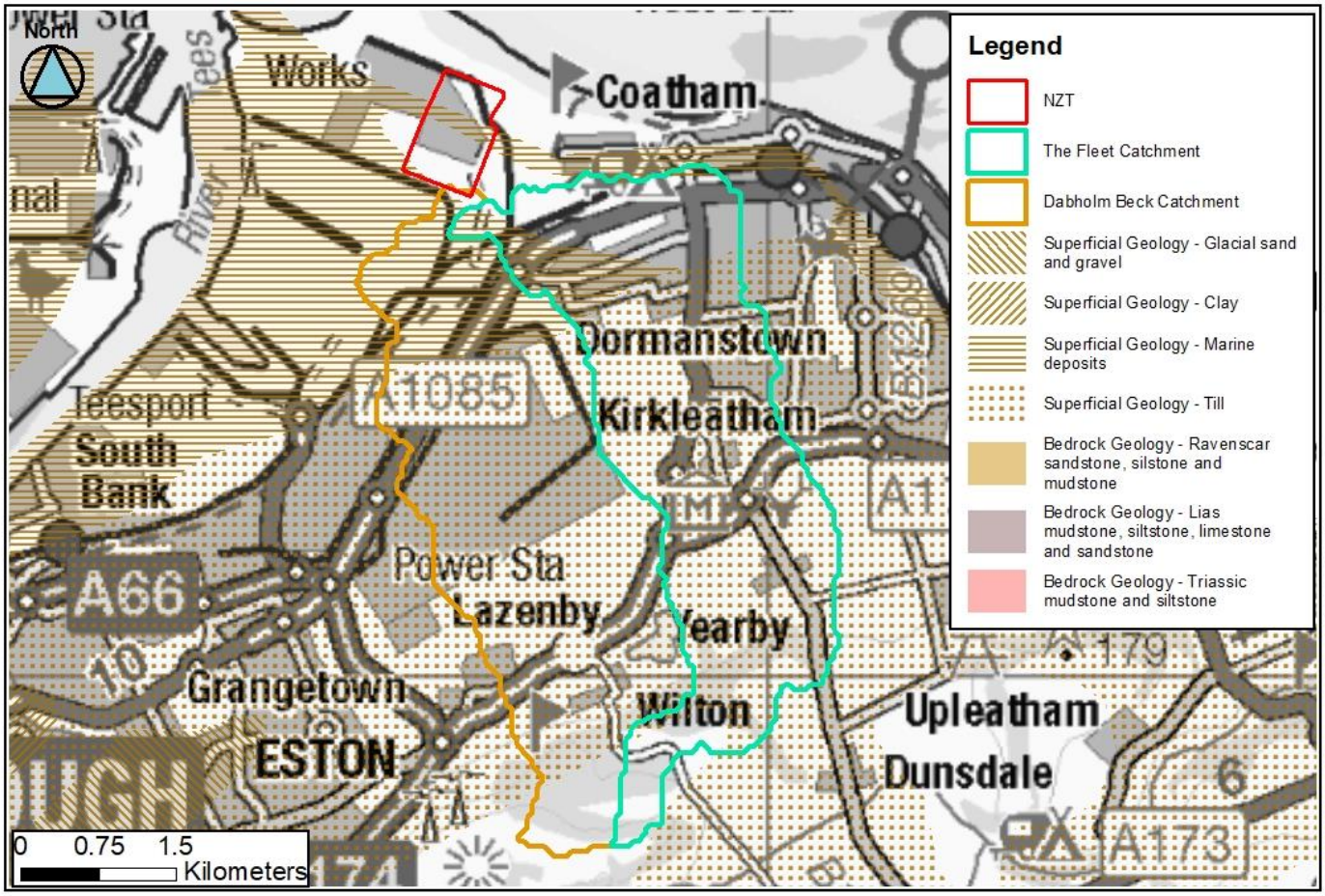

Figure 2-2: Map showing the hydrological catchments and geology at the site

2.1.2 Designations Within or in Proximity to the Site

A search for designations within or within 2km of the site has been completed using the Defra MAGIC portal[3]. Based on the available data and Defra mapping, the site itself is not located within a designated SSSI but the site boundary lies exactly on the border of designated sites shown in Figure 2-3 below.

While the Teesmouth and Cleveland Coast SSSI does extend across the whole of the River Tees estuary, the boundary of the SSSI lies adjacent to the north-eastern site boundary but does not extent into the site boundary itself. However due to the proximity of the site to the boundary of the Teesmouth and Cleveland Coast SSSI, the site is mapped within an area designated as a SSSI Impact Risk Zone.

The function of a SSSI to protect the coastal and freshwater habitats on the estuary. This includes areas of Jurassic and quaternary geology, notably the Redcar Rocks in the area of the site. Sand dunes, saltmarshes, mudflats, rocky and sandy shores, saline lagoons, grazing marshes, reedbeds and freshwater wetlands provide habitats for breeding and non-breeding birds as well as assemblage for invertebrates. The coastal habitat provides breeding areas for harbour seals. As the site is located within the SSSI impact risk zone, planning applications will be required to be assessed for likely impacts on the SSSI. The northern section of the site is also located within a Wild Bird General License exclusion zone

3 https://magic.defra.gov.uk/MagicMap.aspx. [Accessed November 2021].

due to its adjacency with the SSSI protected site, requiring a special licence for any licensable actions to be carried out on site.

To the north of the site, along the Teesmouth and Cleveland Coast, and to the east of the site, on the western side of the Tees Estuary, is a designated Ramsar site for the mudflats which provide a breeding ground for wetland birds. Considerations for this will be the same as those for the SSSI impact risk zone. Approximately 2km to the south east of the site is the Groundwork North East area of community forest. Due to the distance from the site, the proposed development is not anticipated to have any impact on this designated site.

In addition to the SSSI and Ramsar designations, the coastline from Teesmouth to Redcar is part of the Teesmouth and Cleveland Special Protection Area (SPA) designated for ornithological importance (nationally and internationally) and presence of invertebrates. This also covers SSSI unit 25 (Bran Sands and Dabholm Gut/ Cut). Designations in proximity to the site are shown in Figure 2-3 below.

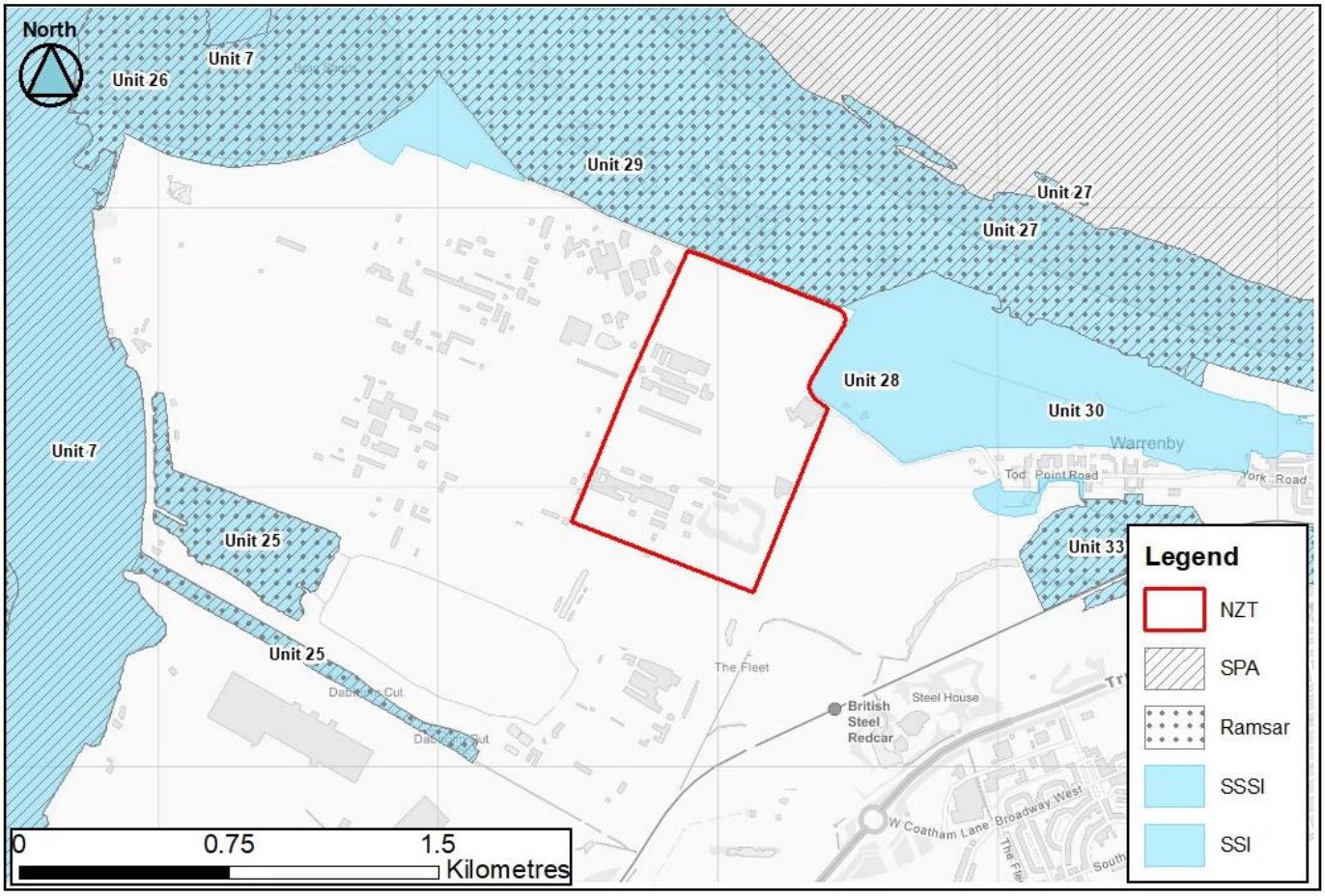

Figure 2-3: Designations in proximity to the site

2.2 Historical and Existing Land Use

Prior to the 1970's, the site was predominately comprised of reclaimed marshland, which was reclaimed in the 1950's. The site was developed as a British Steel Corporation's Iron making complex however at present day the site is vacant brownfield land. The Masterplan notes that the former Redcar Iron Works was located where the NZT site is located and included a tar plant, made ground with slag up to 10m thick. Site elevations, as noted in the FRA supporting the overall NZT development, are approximately 4-10mAOD.

2.3 Proposed Development

NZT aims to "deliver the UK's first zero-carbon industrial cluster, capturing the same amount of energy annually as more than three million homes. As a Carbon Capture, Utilisation and Storage (CCUS) project, Net Zero Teesside is set to decarbonise the area's carbon-intensive businesses by as early as 2030. In-line with national efforts and Teesworks' clean energy commitment, it will help reduce impact on the climate"[4].

A separate Development Consent Order application has been submitted to the Planning Inspectorate for the overall NZT development and the finished ground level for the finished NZT site will be 7.3mAOD.

The remediation of the site proposed for NZT site is the subject of this FRA. The dig depths associated with the remediation works excavations, are to either 3.5m or 5m below ground level (as shown on the map below). Current ground elevations (based on the topographic survey of the area by Atkins in October 2020) are between approximately 4-8mAOD.

4 Teesworks (2021) Net Zero Teesworks. https://www.teesworks.co.uk/the-development/zones/net-zero-teesside [Accessed November 2021]

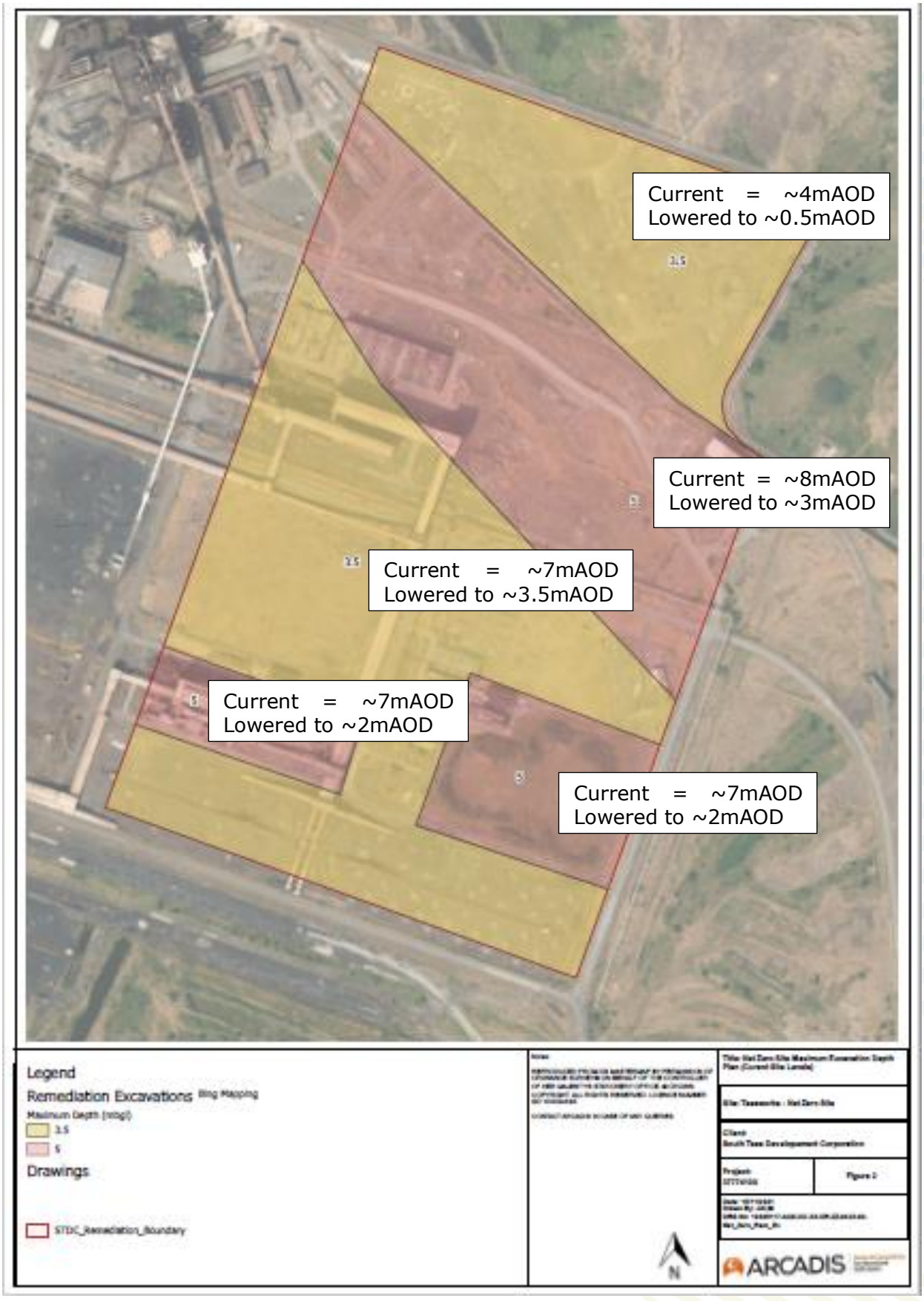

Figure 2-4: Depths of remediation excavation

2.4 Sources of Flood Risk

There are a number of potential sources of flooding that could impact any site; these are fluvial (originating from a watercourse), coastal, groundwater, surface water (pluvial), sewers and blocked culverts and infrastructure failure. The purpose of this report is to provide an assessment of flood risk to the site from these sources.

Within England, the Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG)[5] sits alongside the NPPF and sets out detailed guidance on how this policy should be implemented. It has a three stage approach: assess flood risk, avoid flood risk and manage / mitigate flood risk.

The flood probabilities used to describe Flood Zones as defined in the FRCC-PPG are noted below:

Flood Zone	Annual Probability of Flooding
1	This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).
2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year
3a	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
3b	This zone comprises land where water has to flow or be stored in times of flood. This includes land that would flood with an annual probability of 1 in 20 (5%) or 1 in 25 (4%) or greater in any year, or is designed to flood in an extreme (0.1%) flood. Also referred to as functional floodplain.

As part of the avoidance of flood risk, the Sequential Test is applied which entails steering the development to a location which is in Flood Zone 1 (areas with a low probability of river or sea flooding). If the proposed development is located within Flood Zone 2 then the Exception Test is applied which requires demonstration that the proposed development will a) 'provide wider sustainability benefits to the community that outweigh flood risk and b) that the proposed development will 'be safe for its lifetime without increasing flood risk elsewhere and where possible reduce flood risk overall'.

2.4.1 Fluvial and Coastal Flooding

The Environment Agency's Flood Map for Planning Purposes considers flood risk from a combination of Fluvial and Tidal (coastal) sources but does not take into account the presence of any flood defences. Flood extents for the planning purposes mapping is created using coarse scale UK wide fluvial modelling, and incorporates more detailed modelling of specific rivers done for the EA.

According to the Environment Agency's Flood Map for Planning Purposes[6] (Figure 2-3), the site is located within Flood Zone 1. The closest area mapped within a Flood Zone 2/3 to the site is located 0.05km east of the site and is constrained to the channel of The Fleet.

5 Flood risk and coastal change https://www.gov.uk/guidance/flood-risk-and-coastal-change [Accessed November 2021]

6 Environment Agency Flood Map for Planning (Rivers and Sea) - Flood Zone 2 and Environment Agency Flood Map for Planning (Rivers and Sea) - Flood Zone 3 WMS service. Flood Zone 2 and Flood Zone 3 extents last updated 07/09/2020. Flood Zone 2 and Flood Zone 3 extents obtained from www.data.gov.uk on 06/11/2020.

The NPPF (2019) states that, ignoring the presence of any defences, land located within a Flood Zone 1 is considered to have a low probability of flooding, with a less than a 1 in 1000-year annual probability of fluvial or coastal flooding in any one year. Therefore development of all land uses is considered to be appropriate within Flood Zone 1.

However it should be noted that, due to the course scale used for the development of the extents for Flood Zones 2 and 3, the watercourses flowing through and adjacent to the site are too small to have been included within the models. Therefore, any potential fluvial flooding from these sources may not have been captured within EA mapping.

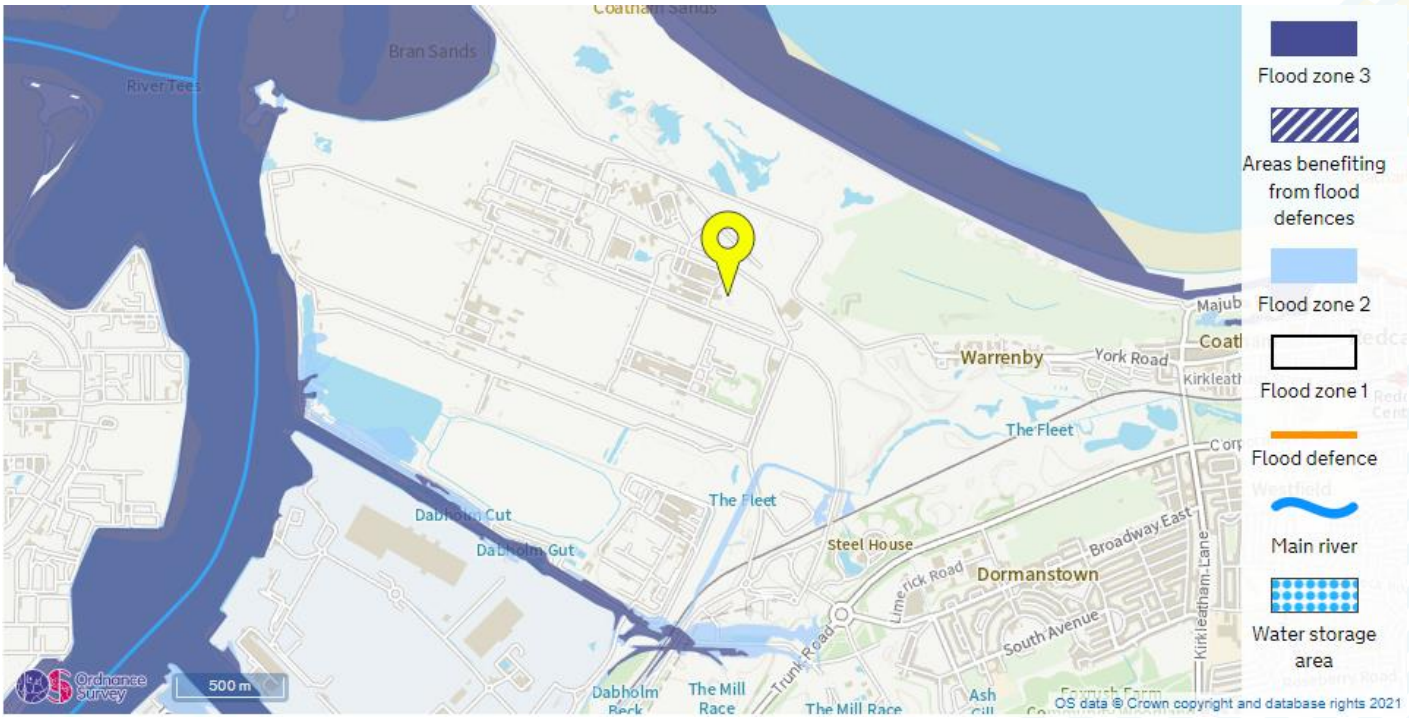

Figure 2-5: Extract from Environment Agency flood map for planning at the site.

The Environment Agency's Long-Term Flood Risk mapping considers flood risk from a combination of Fluvial and Tidal (coastal) sources and takes into account of any flood defences as the presence and condition of flood defences will influence the risk of flooding. The EA flood warning information service long term flood risk map shows the risk split into four categories:

- Very low flood risk – less than 1 in 1000-year probability
- Low flood risk – Between 1 in 1000 and 1 in 100-year probability
- Medium flood risk – Between 1 in 100 and 1 in 30-year probability
- High flood risk – Greater than 1 in 30-year probability.

Figure 2-6 shows the development site is in an area of very low risk since there are no extents of fluvial flooding extending into the site. The Tees Estuary is an area of high risk, due to the tidal influence in this location. While the long-term flood risk mapping indicates that the risk to the site is very low, flood extents provided by the Environment Agency's Flood Map for Planning Purposes should be considered for new development.

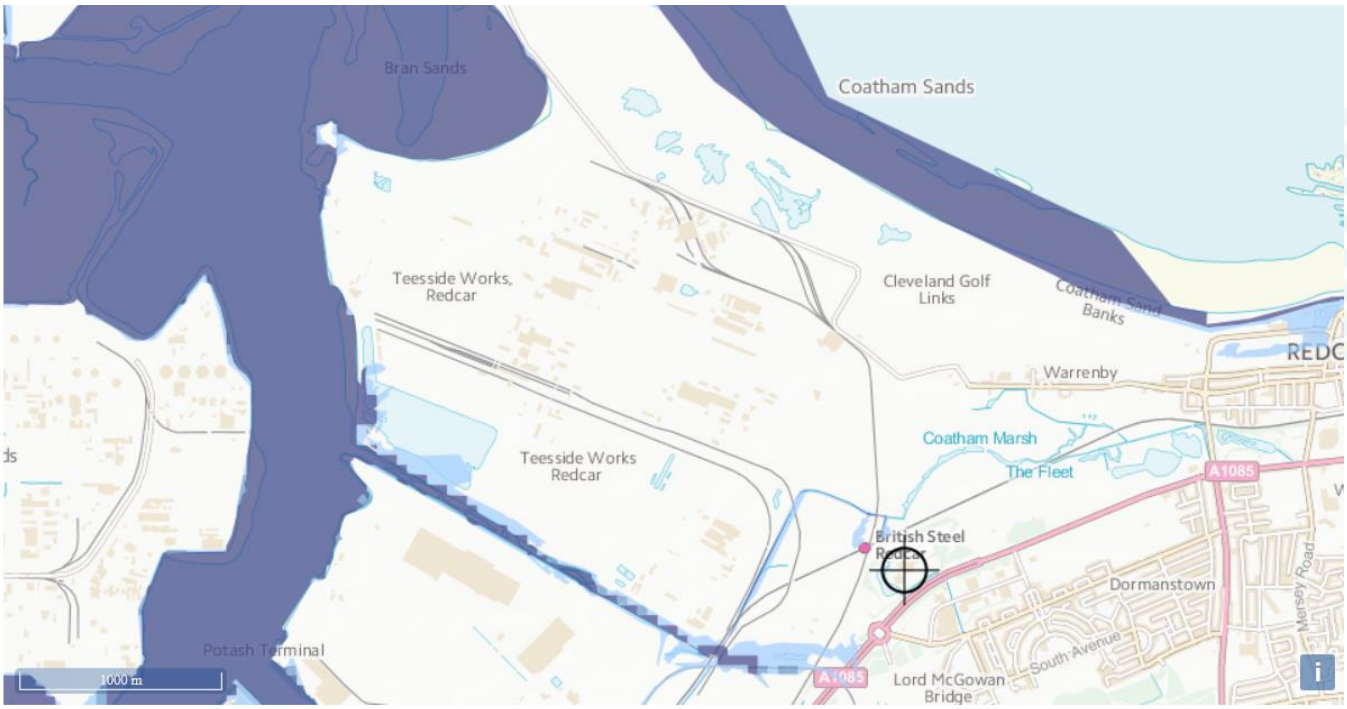

Figure 2-6: Extract from EA map of long term flood risk flood extent from rivers or the sea[7]

2.4.1.1 Climate Change - Fluvial

NPPF notes that there should be a "proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk".

Peak river flow allowances show the anticipated changes to peak flow by river basin district. Redcar is located within the Northumbria river basin district. The application of allowance category is subject to the Flood Risk Vulnerability Classification (categorises development, considering whether it relates to essential infrastructure or, for example development for vulnerable groups in society e.g. hospitals / care homes) and the Flood Zone in which the site lies.

7 Environment Agency Risk of flooding from rivers and sea WMS service. https://flood-map-for-planning.service.gov.uk/confirm-location?easting=457008&northing=525329&nationalGridReference=NZ5700825329 [Accessed November 2021].

Table 2-2: EA Peak flow allowances, Northumbrian River Basin District (use 1961 to 1990 baseline)[8]

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	20%	30%	50%
Higher central	15%	20%	25%
Central	10%	15%	20%

2.4.1.2 Climate Change – Sea Level

There are a range of allowances for each epoch for sea level rise in Northumbria shown in Table 2-3 below derived from EA Figure 2-6 3.

Table 2-3: EA Sea level allowance for each epoch for Northumbria[9]

Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Higher central	4.6 (161)	7.5 (225)	10.1 (303)	11.2 (236)	1.03
Upper end	5.8 (203)	10 (300)	14.3 (429)	16.5 (495)	1.43

Since the original Tees tidal model was developed in 2011/2013 and the above table was published, JBA have undertaken an update to the Tees coastal model on behalf of the EA as part of a separate project in 2019/2020 for Port Clarence / Greatham. The update to the model was based on the UKCP18 uplift values utilising 2017 for a base year for extreme sea levels. Table 2-4 below summarises the results of the updated modelling on the uplift (mm) per epoch.

Table 2-4: Tees Tidal UKCP18 Tees Tidal Uplift Value

Uplift	Epoch	Updated uplift value (mm)
Present day uplift	2017-2019	0.011
UKCP18 2030 uplift	2019-2030	0.071
UKCP18 2050 uplift	2019-2050	0.249
UKCP18 2070 uplift	2019-2070	0.488
UKCP18 2100 uplift	2019-2100	0.947

8 Climate Change allowances https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1 [Accessed November 2021]

9 Climate Change allowances https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-3 [Accessed November 2021]

Table 2-5: Tees Tidal UKCP18 Tees Tidal Climate Change Uplift Levels

Events	2017-2019 (present day)	2030	2070	2100
T2 (2 year)	3.45	3.52	3.94	4.40
T100 (100 year)	3.98	4.05	4.47	4.93
T200 (200 year)	4.08	4.15	4.57	5.03
T1000 (1000 year)	4.33	4.40	4.82	5.28

2.4.1.3 Offshore Wind Speed and Extreme Wave Height Allowance

Wave heights may change because of increased water depths. The frequency, duration and severity of storms could also change. At this point wave modelling has not been included in EA models. If required at a future stage in the project an allowance of 10% should be applied to coastal modelling. Nationally available flood maps do not currently show the impact of waves.

Table 2-6: EA Offshore wind speed and extreme wave allowance

Applies around all the English coast	2000 to 2055	2065 to 2125
Offshore wind speed allowance	5%	10%
Offshore wind speed sensitivity test	10%	10%
Extreme wave height allowance	5%	10%
Extreme wave height sensitivity test	10%	10%

2.4.2 Pluvial Flooding

The Environment Agency's Risk of Flooding from Surface Water map considers flood risk from surface water (pluvial) sources. Flooding from pluvial sources can occur during times of heavy rainfall which exceeds the infiltration capacity of the ground and can also lead to exceedance in drainage capacity.

According to the Environment Agency's Risk of flooding from Surface Water map[10] (Figure 2-5), the site is not at risk of flooding from pluvial sources for a 1 in 30-year pluvial flood event (representative of a high flood risk) and there are only minor isolated areas mapped at risk for a 1 in 100 year pluvial flood event (representative of a medium flood risk) – likely due to localised depressions within the site boundary.

There are areas mapped at risk for a 1 in 1000 year pluvial flood event (representative of a low flood risk) however the majority of the site is mapped as being at a very low pluvial flood risk.

Analysis of pluvial risk mapping, OS mapping and LiDAR elevation data indicates that there is no clear flow path present and that the areas mapped at risk of a 1 in 1000 year pluvial event are more areas of localised depressions within the site boundary which results in pooling of surface water. This is due to the uneven nature of the DTM at the site and will

10 Environment Agency Risk of Flooding From Surface Water Depth: 3.3 percent annual chance, Environment Agency Risk of Flooding From Surface Water Depth: 1 percent annual chance and Environment Agency Risk of Flooding From Surface Water Depth: 0.1 percent annual chance WMS service. 3.3 percent, 1 percent and 0.1 percent extents last updated 09/03/2020. 3.3 percent, 1 percent and 0.1 percent extents obtained from www.data.gov.uk on 06/11/2020.

differ if the site is developed and ground levels are evened out. For the very minor areas mapped at medium flood risk, maximum pluvial flood depths are modelled to be between 0.3-0.6m. For a low flood risk scenario, the majority of areas mapped at risk have flood depths under 0.9m however there are a few areas isolated areas which are mapped to have flood depths over 0.9m.

The Fleet watercourse has a more continuous area of surface water flood risk as shown on the map below, which may represent a flow path for surface water flooding in the area, especially if a surface water flood event is combined with a fluvial flood event. However, the maps do not show a pathway from The Fleet to the site.

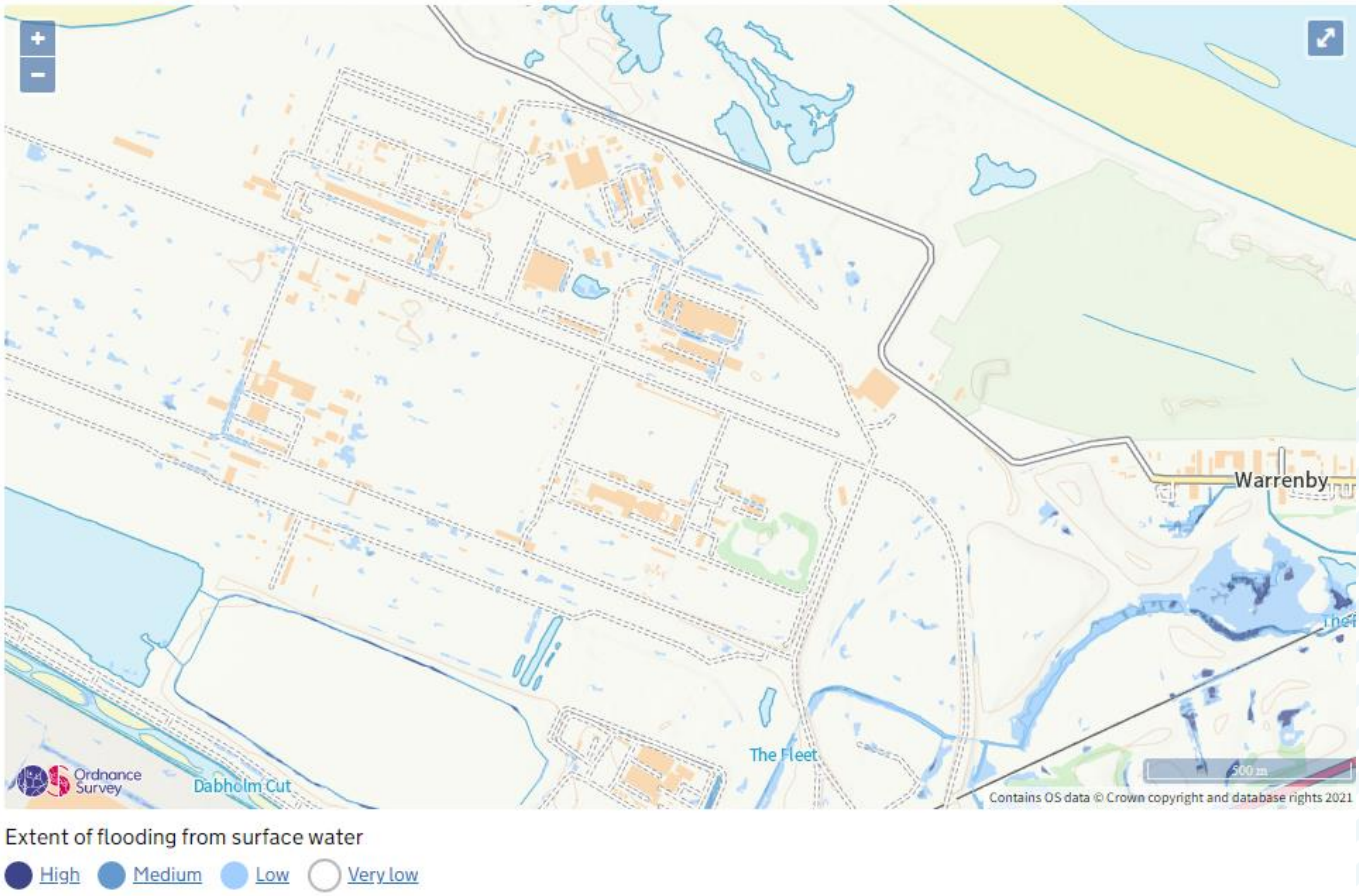

Figure 2-7: Extract from EA Long term surface water flood risk map[11]

2.4.2.1 Climate Change

With respect to surface water flood risk mapping and design of drainage systems (including any potential blue-green infrastructure and minor watercourses with a catchment of less than 5km^2) the allowances outlined in the table below should be used. As the development has a design life of a minimum of 50 years the default design parameters are to design for the 20% and sensitivity check for the 40%.

11 EA Long term flood risk for surface water. https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=453987&northing=522641&address=10034526609&map=SurfaceWater [Accessed November 2021]

Table 2-7: EA Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

2.4.3 Groundwater Flooding

Groundwater flooding is defined by the British Geological Survey as following:

'The emergence of groundwater at the ground surface away from perennial river channels or the rising of groundwater into man-made ground, under conditions where the 'normal' ranges of groundwater level and groundwater flow are exceeded. Exceptionally large flows from perennial springs or large flows from intermittent or dormant springs, which also come under the above definition of groundwater flooding, can cause both localised flooding in the vicinity of the springs and down gradient where surface water drainage channels may not be adequate.'

This means that areas which are regularly waterlogged are excluded from the definition of groundwater flooding.

In addition to where groundwater emerges, the rate of flow is also an important consideration in understanding the risk associated with groundwater. In general, low permeability deposits such as clay are more prone to waterlogging than higher permeability deposits such as sands and gravels. However, they yield less water, and therefore small-scale interventions (e.g. small drains) can often effectively supress the local water table. On the other hand, a similar drain cut into high permeability gravels may quickly be overwhelmed and inundated with groundwater.

2.4.4 Sewers, Culverts and Bridges

The watercourses in the vicinity of the site have been significantly modified and have either been culverted or straightened. The main structures are:

- Culvert conveying The Fleet under the Former Hot Metals Transfer Railway.
- Culvert conveying The Fleet under the Darlington to Saltburn Railway line.
- Culvert conveying The Fleet under two access road.
- Culvert conveying Dabholm Beck under the major operations freight railway line after the confluence with The Fleet

The Fleet flows under a number of culverts before the confluence with Dabholm Beck to the south of the site. Online imagery has been used to identify further structures along the channel. The first upstream culvert within proximity to the site along The Fleet directs flow a north westerly direction under the former Hot Metals Transfer Railway and an internal road, then continues in a straight culvert in a north west direction within the site boundary. Culvert width is approximately 6-7m wide (0.4km east of the site). 0.3km downstream of the first culvert, The Fleet flows underneath a second access road (culvert width approx. 2-3m, 0.08km east of the site). 0.4km south of the site, The Fleet flows underneath the Darlington to Saltburn Railway line before the confluence with Dabholm Beck by a culvert that is approximately 6m wide.

Immediately downstream of the confluence of The Fleet into Dabholm Beck, the watercourse flows into a culvert to divert flow underneath the major operations freight railway line and towards the River Tees (approximate culvert width 6.5m). 1km downstream, Dabholm Beck flows under an access road (approximate culvert width 3.5m) and subsequently underneath

a vehicular bridge (60m width) and a foot bridge (8.4m width). The Dabholm Beck frows through a tidal valve weir before becoming the Dabholm Gut and flowing into the River Tees.

Within the site boundary, two drainage pipes are located within the northern site boundary. The Redcar Coke Ovens Outfall pipe flows from the north western site boundary in a north westerly direction to the River Tees. The Redcar Power Station Outfall drains an area just outside of the north eastern site boundary but flows underneath a section of the site, in a northern direction, before discharging into Tees Bay.

2.4.5 Reservoir Flooding / Breach

The risk of flooding from reservoirs is related to the breach of a large reservoir (a large reservoir is classified as a reservoir which can hold over 25,000m^3 of water) and is based on the worst-case scenario. Since mapping is a prediction of a credible worst case scenario, it's unlikely that any actual flood would be as large as is predicted within the model.

According to the Environment Agency's Risk of Flooding from Reservoirs - Maximum Flood Extent map[12] (Figure 2-6), the site is not at risk of flooding from reservoir sources. The Fleet Channel is however mapped to be at risk from flooding from the two small reservoirs which lie to the south east of the site (Brine Reservoir, Wilton No.1 (NGR: NZ5880720741) and Brine Reservoir, Wilton No.1 (NGR: NZ5881920515). However, whilst there would be an increase in water depth in these channels, the maps do not suggest that the flood extents would extend beyond the channel width.

12 Environment Agency Risk of Flooding From Reservoirs – Maximum Flood Extent WMS service. Extent last updated 15/10/2020. Extent obtained from www.data.gov.uk on 06/11/2020.

Figure 2-8 Extract from the EA Flood Maps for reservoir flooding

2.5 Flood History

The following sources were consulted as part of the as part of the Data Collection and Baseline Assessment[13] undertaken as Phase 1 of the Water Management Strategy for the Teesworks (then STDC) development.:

- **Readily available archives** - internet based sources including the British Hydrological Society Chronology of British Hydrological Events[14] and Google Newspaper Archive[15]. No specific information for this area was available from these archives.
- **Environment Agency (Risk Management Authority under the Water Management Act and Flood Risk Regulations)** - open data records noted the occurrence of one flood event within the Tees Estuary on 05/12/2013 and was recorded to be due to operational failure/breach of defence and the source was coastal. This event did not breach onto the site. The flood event was due to a high

13 Phase 1 – Data Collection and Baseline Assessment, JBA Consulting for Faithful & Gould on behalf of Teesworks, May 2020

14 Chronology of British Hydrological Events. http://cbhe.hydrology.org.uk/ [Accessed 18 Dec 2020].

15 Google Newspaper Archive. https://news.google.com/newspapers [Accessed 18 Dec 2020].

spring tide mixed with the failure of the flood defence embankment at the south side of Greatham Creek (4km to the west of the site)[16]. Since this event, a new flood defence scheme has been completed at Port Clarence and Greatham South[17].

- **Redcar and Cleveland Borough Council (Lead Local Flood Authority and Risk Management Authority under the Water Management Act and Flood Risk Regulations)** - provided historic flood photographs for the wider Teesworks site, (requested as part of the flooding strategy work), these were not georeferenced and lack name and date information which makes locating and using them difficult. Further historic flood records were requested[18] but the RCBC had no records for the main site. This does not indicate that no incidents have occurred but that none have been recorded.
- **The SFRA reports from 2010**[19] **and 2016**[20] - use of existing data from these projects has been granted by RCBC for this project. The level 1 report states that RCBC has little data on fluvial or tidal flooding. In this report NW provided their register on surface water flood events. These were concentrated in the main residential areas of Eston and Redcar and none were identified in the vicinity of the site.
- **Historical Mapping** – The online National Library of Scotland (NLS)[21] archives have been reviewed. These show the site was originally mudflats in the Tees estuary (The Marches). Between 1920 and 1940 the north eastern side of the site had been developed for industrial use, with the remainder of the side remaining as The Marches. None of the historic mapping had any levels recorded.

2.6 Flood Estimation

Flood risk is a combination of the likelihood of flooding and the potential consequences arising. It is assessed using the source – pathway – receptor model.

Flood mapping for fluvial and coastal / tidal risk are available from previous studies undertaken. These studies extend across the site and the surrounding Teesworks area and which can be used to inform this high level assessment of flood risk:

- Tidal: The Tees Estuary model developed for the EA by JBA documents coastal flood risk for entire site. This was recently updated by JBA to account for the UKCP18 climate change uplift values. Wave action is not accounted for however the protection offered by the existing sand dunes system and historic railway embankment have been included.
- Fluvial: The Fleet system comprising of the Fleet and its main tributaries were modelled for Redcar & Cleveland Borough Council by JBA in 2015. The study featured a detailed survey which included all of the in-channel structures within the Teesworks site.

16 Stockton-on-Tees Borough Council LLFA Flood Investigation Report, Tees Tidal Flooding, March 2014

17 "Hartlepool public invited to opening of new £14.5m flood defence scheme", Hartlepool Mail , 16 October 2018

18 Email from Nigel Hill, Drainage & Flood Risk Manager of Council flood team, received 30 January 2020

19 Redcar and Cleveland Borough Council Level 2 Strategic Flood Risk Assessment, August 2010

20 Redcar and Cleveland Borough Council Level 1 Strategic Flood Risk Assessment Update, May 2016

21 National Library of Scotland. https://maps.nls.uk/geo/explore/#zoom=4&lat=55.78537&lon=-3.16449&layers=1&b=1 [Accessed 18 Dec 2020]

No surface water modelling had been undertaken to date and since the EA flood maps indicated that there were pockets of pluvial flooding across the site, a preliminary surface water model was run to give a high-level overview of pluvial flood risk as part of the Data Collection and Baseline Assessment[22] undertaken as Phase 1 of the Water Management Strategy for the Teesworks development. Details of the pluvial modelling and analysis of flow pathways and potential flood receptors are provided below.

The preliminary pluvial mapping will be updated by more detailed mapping in Phase 2 of the works for the Teesworks strategy which will allow for a more detailed analysis of flood risk.

2.6.1 Approach to Peak Flow Estimation

Preliminary hydrological data for the high level assessment of pluvial flooding was based upon Flood Estimation Handbook (FEH) catchment areas (shown in Figure 2-2) and FEH13 rainfall, which were downloaded from the FEH web-service tool along with the catchment descriptors (tabulated in Table 2-1).

2.6.2 Hydraulic Modelling

The preliminary surface water flood maps were generated using InfoWorks Integrated Catchment Modelling (ICM) software version 9.5. InfoWorks ICM is an advanced integrated catchment modelling software used to model complicated hydrological and hydraulic systems efficiently. It also allows the user to combine natural solutions with piped (network) modelling to suggest improvements to capacity and create scenarios to optimise flood risk management. The inputs required were a Digital Terrain Model (DTM) to represent the ground of the area of interest and FEH13 rainfall.

The DTM was created using LiDAR 2m spatial resolution DTM data. Denser LiDAR data is available but was not utilised at this high-level stage in the project. DTM processing was completed using 3D analyst tools in ArcMap 10.4 with ASCII files exported and added to InfoWorks ICM to create the ground model.

The modelling directly applied the FEH13 rainfall from the Dabholm Gut catchment over the 2m LiDAR DTM. The model was run for the 100-year and 100-year plus climate change scenarios. Further model runs will be undertaken during more detailed analysis in Phase 2 of the study.

The model results were exported into geodatabases for analysis within ArcMap 10.4 which was used to create the following flood risk screening maps:

- 100yr surface water
- 100yr +20%cc surface water
- 100yr+ 40%cc surface water
- 100yr fluvial (Fleet Model)
- 200yr coastal +SLR
- 200yr coastal +SLR, 100yr surface water, Fleet 100yr
- 200yr coastal +SLR, 100yr+40%cc

2.6.3 Assumptions and Limitations of the Modelling

The modelling undertaken was for the preliminary stage of the water management strategy and due to the high-level nature of the preliminary flood risk screening exercise it was necessary to make a number of key assumptions and apply limitations for the modelling as follows:

22 Phase 1 – Data Collection and Baseline Assessment, JBA Consulting for Faithful & Gould on behalf of Teesworks, May 2020

- Limited to 2 scenarios 100yr and 100yr plus climate change.
- A 20% and 40% climate change uplift has been applied to the rainfall hyetographs in line with EA guidance.
- The model was run as a full blockage scenario. This highlights potential flood risk and details areas within the development suitable for conveyance. It can also inform more detailed modelling.
- The model does not include any losses to account for interception into existing surface water drainage systems or infiltration into the ground. A value of 70-75% is applied
- The model does not account for flooding of the sewer network.
- FEH Catchment data from the surrounding areas were used to allow direct application of rainfall on LiDAR within the sites of interest.
- A 2m resolution DTM was utilised.
- A storm duration of 60 minutes was used to allow high level assessment of overland flow paths.

N

Bran Sands

Industry outflow pipe

Industry outflow pipe

Redcar Coke Oven Outfall

Redcar Blast Furnace Outfall

Dabholm Cut

Dabholm Cut

The Fleet

Fleet Beck

British Steel Redcar

Steel House

0 0.25 0.5 1 km

Legend

NZT

100-year Surface Water Extents

Depth (m)

High : 5.69257

Low : 0.1

Culverted Watercourses

Rev.	Modifications	Date	Drawn	Checked	Approved

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for

South Tees Development Corporation

FLOOD RISK SCREENING MAPS
1:100YR SURFACE WATER FLOOD RISK

Scale: 1 : 5,000 @ A1	Drawn	SC 09/11/2020
	Checked	RD
	Approved	RD

Digital File Name: EPB -JBAU-00-TF-M2-EN-0009-The_Foundry_100yr_Fleet_Model

Drawing Number:	Sheet No.:	Status:	Rev.:
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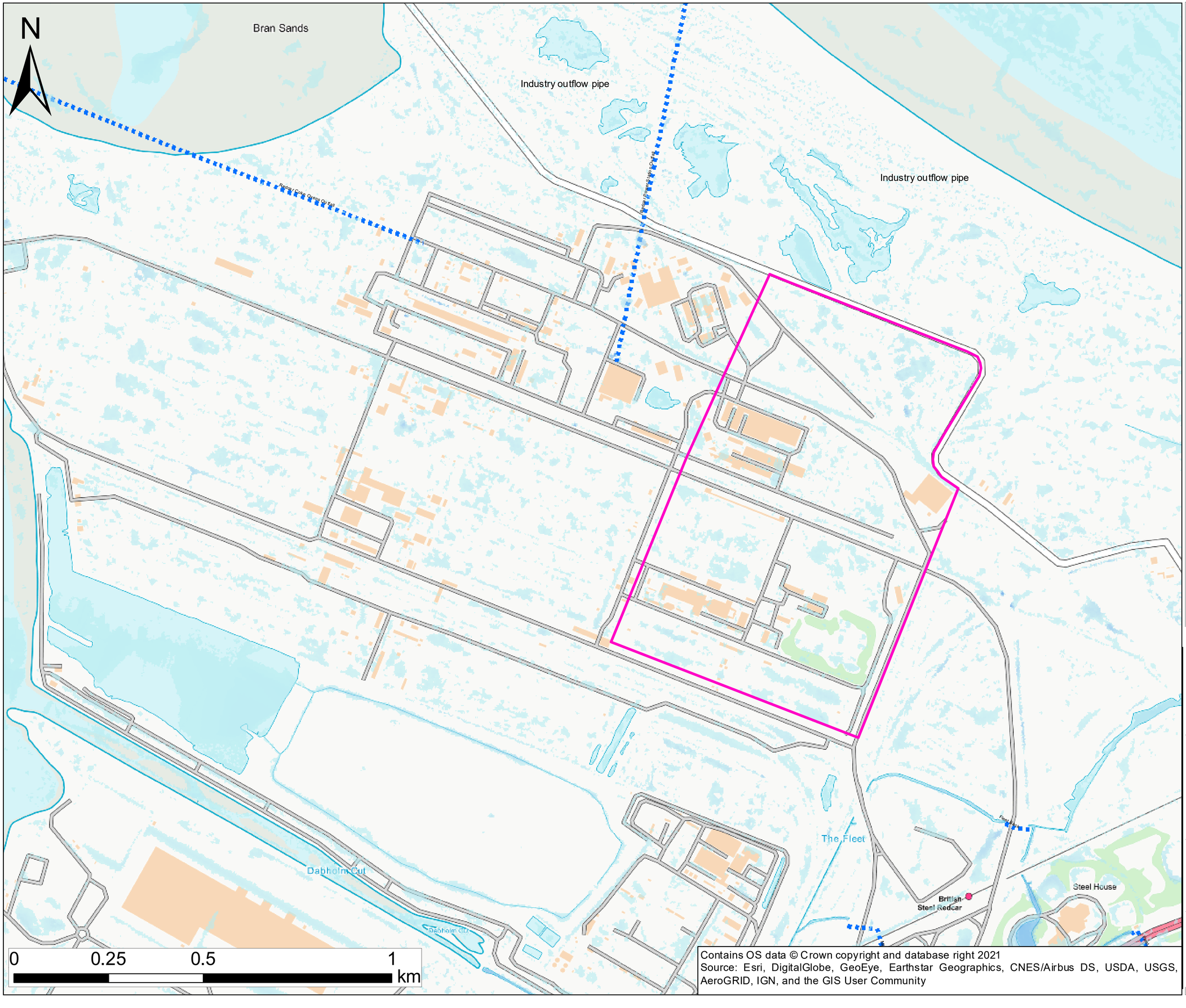

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Legend

NZT

100-year + 20% CC Surface Water Extents

Depth (m)

High : 5.76198

Low : 0.1

Culverted Watercourses

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South Tees Development Corporation

FLOOD RISK SCREENING MAPS
1:100YR + 20% CC SURFACE WATER FLOOD RISK

Scale: 1 : 5,000 @ A1	Drawn	SC 09/11/2020
	Checked	RD
	Approved	RD

Digital File Name: EPB-JBAU-00-TF-M2-EN-0003-The_Foundry_100yr_20CC_SW

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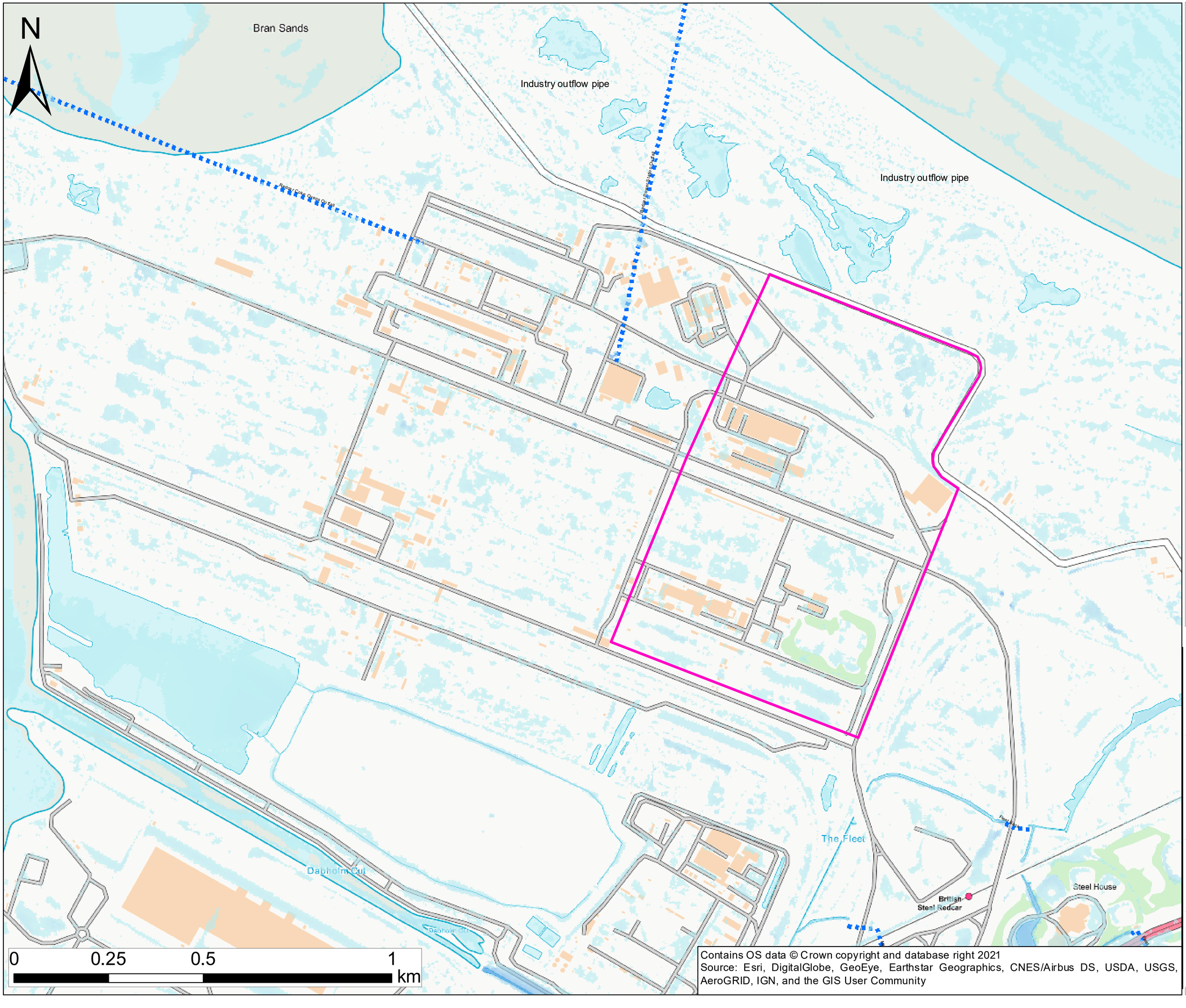

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Legend

NZT

100-year + 40 % CC Surface Water Extents

Depth (m)

High : 6.90909

Low : 0.100001

Culverted Watercourses

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FLOOD RISK SCREENING MAPS
1:100YR + 40% CC SURFACE WATER FLOOD RISK

Scale: 1 : 5,000 @ A1	Drawn	SC 09/11/2020
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Digital File Name: EPB-JBAU-00-TF-M2-EN-0005-The_Foundry_100yr_40CC_SW

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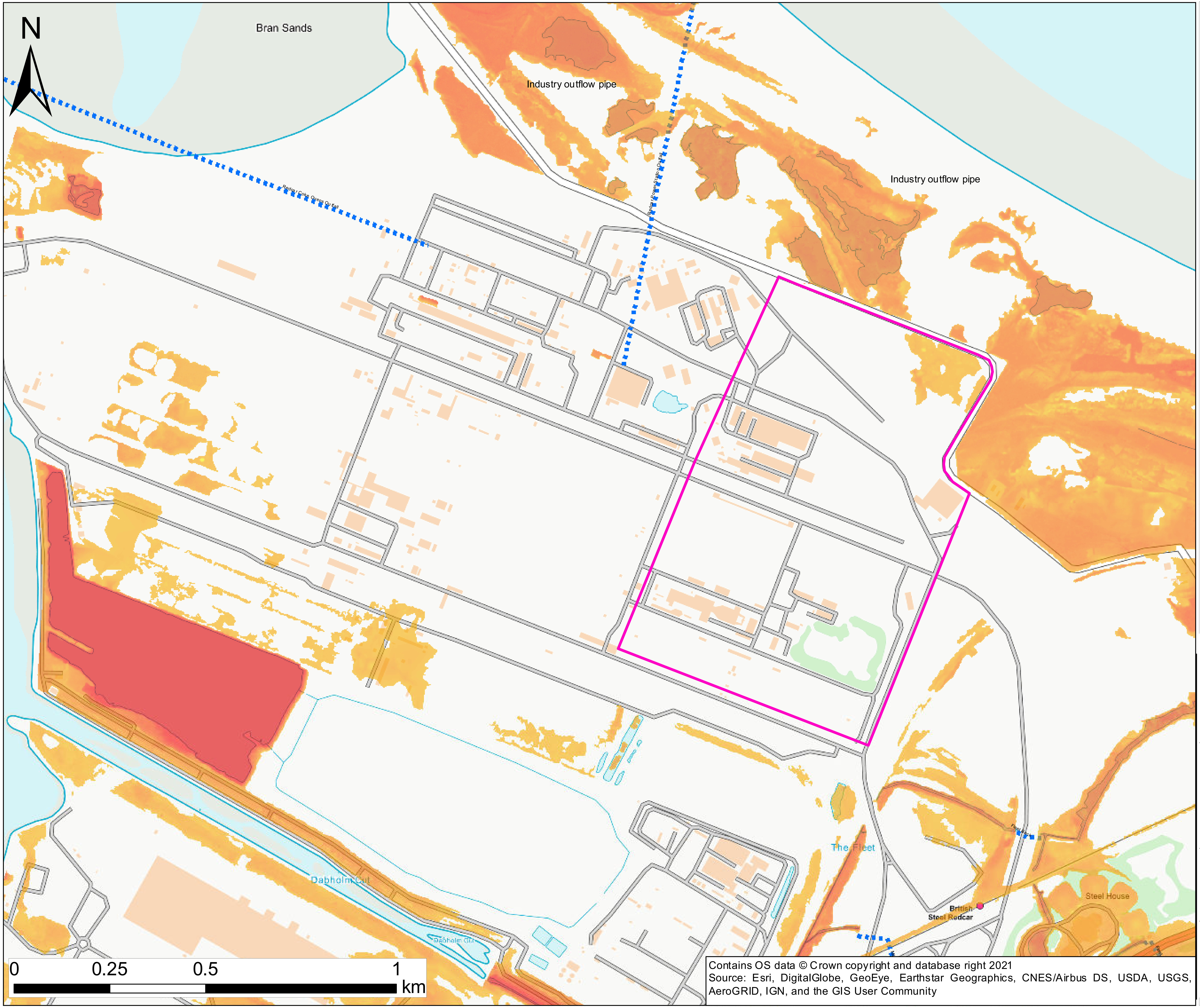

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NZT

200-year Coastal Risk + Sea Level Rise Allowance

Value

High : 7.42582

Low : -2.98812

Culverted Watercourses

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FLOOD RISK SCREENING MAPS
1:200YR COASTAL FLOOD RISK + SEA LEVEL RISE

Scale:		
1 : 5,000 @ A1	Drawn	SC 09/11/2020
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	Approved	RD

Digital File Name: EPB-JBAU-00-TF-M2-EN-0005-The_Foundry_200yr_C

Drawing Number:	Sheet No.:	Status:	Rev.:
0004	4 of 7	S3	P02

N

Bran Sands

Industry outflow pipe

Industry outflow pipe

Redcar Coke Ovens Outfall

Redcar Power Station Outfall

The Fleet

Dabholm Gut

Dabholm Gut

Steel House

British Steel Redcar

0 0.25 0.5 1 km

Legend

NZT

100-year + 20% CC Surface Water Extents

Depth (m)

High : 5.76198

Low : 0.1

200-year Coastal Risk + Sea Level Rise Allowance

Value

High : 7.42582

Low : -2.98812

Culverted Watercourses

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FLOOD RISK SCREENING MAPS
COMBINED FLOOD RISK

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Digital File Name: EPB-JBAU-00-TF-M2-EN-0005-The_Foundry_200yr_C

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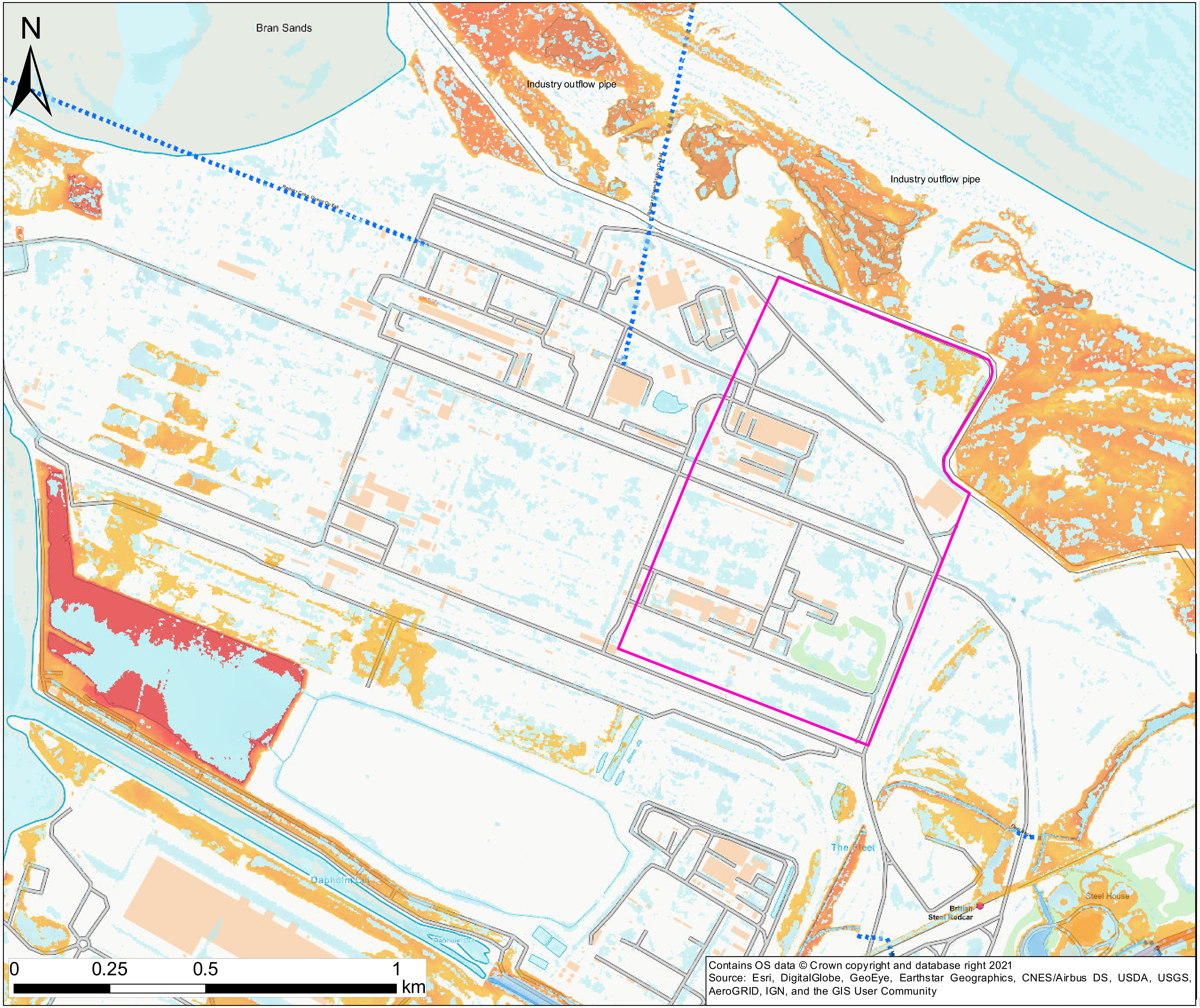

Legend

NZT

100-year + 40 % CC Surface Water Extents

Depth (m)

High : 6.90909

Low : 0.100001

200-year Coastal Risk + Sea Level Rise Allowance

Value

High : 7.42582

Low : -2.98812

Culverted Watercourses

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FLOOD RISK SCREENING MAPS
COMBINED FLOOD RISK WITH CLIMATE CHANGE

Scale:	Drawn	SC 09/11/2020
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Drawing Number:	Sheet No.:	Status:	Rev.:
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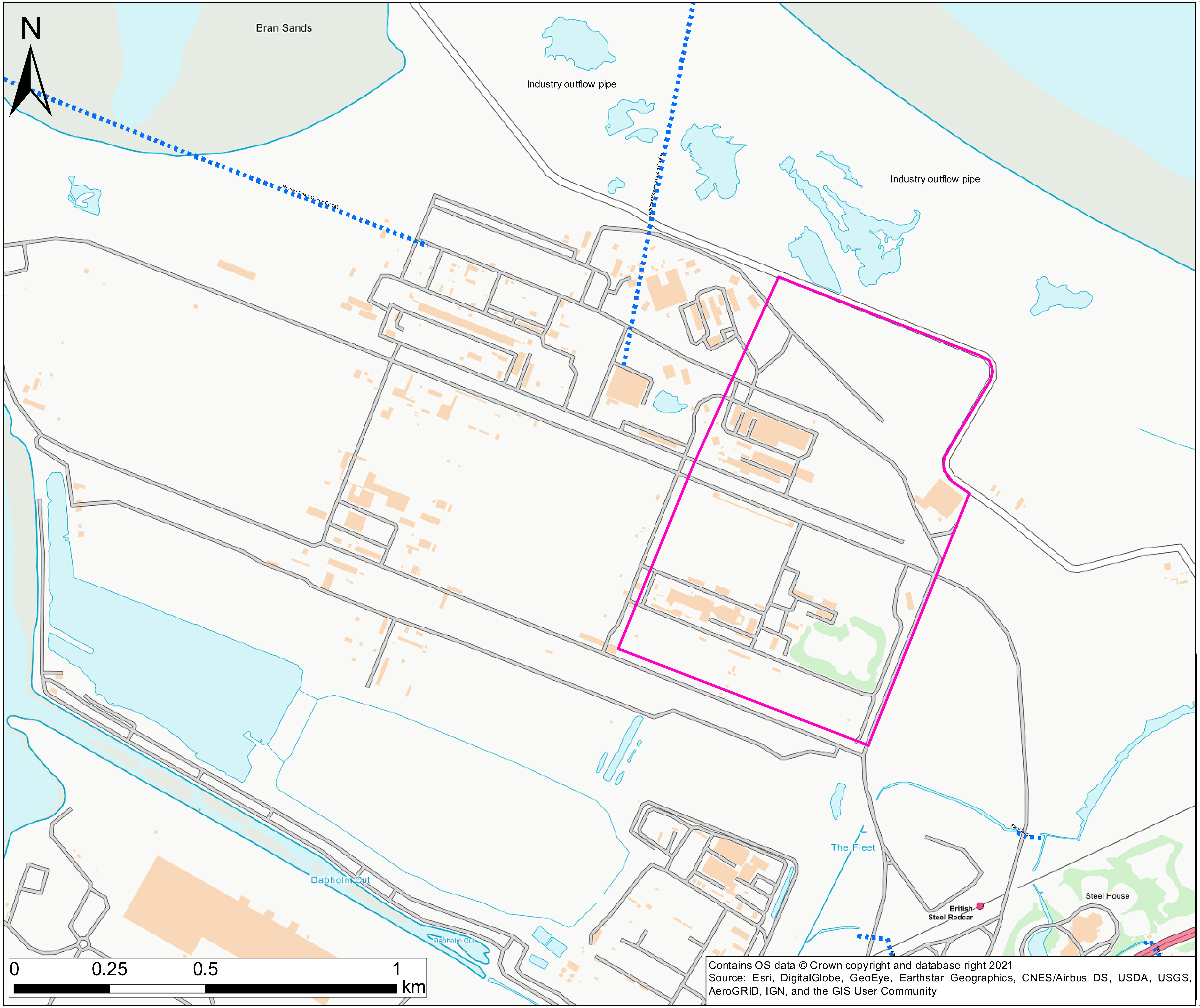

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Legend

- NZT
- Culverted Watercourses
- Fleet Model 100-year Flood Extents

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South Tees Development Corporation

FLOOD RISK SCREENING MAPS
1:100YR FLEET MODEL RESULT

Scale:		Drawn	SC 09/11/2020
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		Approved	RD

Digital File Name: EPB-JBAU-00-TF-M2-EN-0009-The_Foundry_100yr_Fleet_Model

Drawing Number:	Sheet No.:	Status:	Rev.:
0007	7 of 7	S3	P02

2.6.4 Pre-Development Scenario

Findings from previous studies and the surface water modelling described above have been used to summarise flood risk to the site from different sources.

At the flood risk screening stage it is necessary to assign a preliminary flood risk to each of the development areas. Flood risk is typically classed based on likelihood of flooding to occur combined with the severity and consequence of the flooding. At this stage in the process information is limited to the return periods available during the data gathering process and preliminary surface water modelling. Hence in order to give preliminary flood risk categories the following scoring system has been adopted.

- High: Substantial coverage of proposed development area by flooding of one or more flooding sources. Flow paths are often clear and linked with flood water ponding at substantial depths (1m>).
- Moderate: Moderate cover of the proposed development area by one or more flooding sources. Flow paths maybe less clear with areas of ponding typically between 0.3m-1m deep.
- Low: Only a small portion of the proposed developable land is affected by ponding of shallow depths typically up to 0.3m deep. Isolated areas of shallow ponding are frequent typically related to the demolition of industrial buildings.
- Very Low: Little to no flooding within developable area. Any flooding is typically isolated to localised low points at depths of <0.3m. Isolated areas of shallow ponding are frequent typically related to the demolition of industrial buildings

2.6.4.1 Fluvial Flood Risk

The site is at a low risk from fluvial flooding as the maps shows no fluvial flood extents within or adjacent to the site. This is consistent with the EA Flood Maps which show the site lies within Flood Zone 1. A site specific hydraulic model will be required to develop the drainage design and to analyse the flood risk from the surface water and in relation to The Fleet and Dabholm Beck. However, at this stage we can assume that as both The Fleet and Dabholm Beck receive flows from culverted watercourses, the inflows are limited to the capacity of the upstream and downstream culverts. Both channels are large open channels with significant capacity. The main flood risk relates to the performance of the downstream culverts after the confluence of The Fleet and Dabholm Beck into the River Tees, particularly when under tidal influence.

2.6.4.2 Coastal and Tidal Flood Risk

The site is mostly at low risk from coastal and tidal flood risk. This is consistent with the EA Flood Maps which show the site lies within Flood Zone 1. As part of the Level 2 Strategic Flood Risk Assessment (SFRA), a detailed model was created to supersede the broad scale EA tidal flood risk mapping and this shows the north eastern corner of the site is at risk under a 200yr event for coastal and tidal flooding. Inundated areas have flood depths on average of 0.2m with a small 30m long area over 1m, due to topographic depressions in the DTM data used within the model. This area of the site where flood depths are 1m are considered to be at moderate risk.

The coastal flood modelling does not take into account the presence of tidal limiting structures such as flap valves and weirs. As such there is a lower confidence in the flood mapping of the inland areas.

2.6.4.3 Surface Water Flood Risk

The site is mapped as being at a moderate pluvial flood risk under a climate change scenario (100yr +40% cc). The EA Flood Maps which show the site lies within Flood Zone 1 but this does not include an allowance for climate change.

The areas shown in the modelling to be at most risk are the localised depressions associated with the previous land use of the site. There are overland flow paths associated with surface water flooding but within the site. For the very minor areas mapped at medium flood risk, predominantly formed of a large number of shallow (0.3m-0.9m deep) localised depressions in which water can pond. With redevelopment there is the opportunity to regrade the ground and provide positive overland flow paths to drainage channels where surface water can be managed.

2.6.4.4 Groundwater Flood Risk

Rainfall is likely to enter the groundwater system underlying the site by direct recharge through the Made Ground, glacial till and tidal flat deposits. Groundwater within the superficial deposits is likely to comprise locally perched water tables within permeable horizons or sands and silts which overly low permeability clay layers.

A desk study with a groundwater constraints assessment and conceptual model would be required to develop a detailed understanding of potential groundwater flooding. As an indication of potential flood risk, reference has been made to the analysis undertaken for the Water Management and Flooding Environmental Statement chapter prepared for The Foundry site that is adjacent to the NZT site, it is unlikely that areas of groundwater within the superficial deposits are hydraulically connected or are part of regional groundwater flow, hence there may be local variations in groundwater levels.

It is anticipated that there is a low risk of groundwater emergence on the ground surface. Groundwater flooding to the site may need to be considered if remediation works entail cutting into the underlying bedrock aquifer as the superficial aquifers have a low permeability – for the purpose of this FRA, it is assumed that dig depths associated with the remediation works do not extend into the bedrock aquifer.

Within the underlying Redcar mudstone, groundwater input is likely from direct recharge where it is exposed to the south, in addition to infiltration through permeable parts of the overlying superficial deposits. Within the site, the Redcar mudstone forms a confined Secondary A aquifer.

2.6.5 Post Development Scenario

In terms of planning and plot-based design it is likely that the tidal levels are to be the defining factor in terms of plot elevations. A tidal flood level of 5.03m AOD represents the 1:200yr Coastal Flood Risk + Sea Level Rise Allowance to 2100 design scenario. At time of writing, proposed ground levels of the site post-development are 7.3mAOD.

For the purposes of this FRA, the post development scenario refers to the site activities related to remediation. The remediation works will entail lowering site elevations by 3.5m to 5m below current ground levels which lie between 4 and 8mAOD. The annotations on Figure 2-4 indicate the approximate elevations in mAOD to which ground levels will be lowered – these range from 0.5mAOD at the north east of the site, 3-3.5m in the centre of the site and 2m to the south /south east of the site.

The whole site lies within Flood Zone 1 on the EA flood maps for all types of flooding.

Based on the modelling described above, the indicative mapping shows the following for the different types of flood risk.

2.6.5.1 Fluvial Flood Risk

The post development site lies outwith the 100yr fluvial flood extents

2.6.5.2 Coastal and tidal flood risk

The 1:200yr Coastal Flood Risk + Sea Level Rise Allowance to 2100 design scenario is 5.03mAOD. Lowering the site by the levels outlined in Figure 2-4 show that the site elevations will be lowered to approximately 0.5mAOD and 3.4mAOD which is below the 5.03mAODm meaning that the site would be at risk from between 3 and 4m of coastal and tidal flooding during the remediation activities.

2.6.5.3 Surface water

The areas shown in the modelling for the pre-development site shows a large number of shallow (0.3m-0.9m deep) localised depressions in which water can pond localised depressions associated with the previous land use of the site. Under a 100year scenario for surface water, larger areas may be at risk as the undulations of the land causing localised surface water flooding, would likely be flattened during remediation activities and so increasing the area across which pluvial flooding could occur, although increasing the area could reduce the flood depths.

2.6.5.4 Groundwater

There is a residual risk of groundwater flooding throughout the Teesworks site. Groundwater flooding to the site may need to be considered if remediation works entail cutting into the underlying bedrock aquifer as the superficial aquifers have a low permeability – for the purpose of this FRA, it is assumed that dig depths associated with the remediation works do not extend into the bedrock aquifer.

3 Flood Mitigation Measures

3.1 Flood Warning System and Existing Alleviation

The site is not within an EA Flood Warning or Flood Alert area. Within the Tees Estuary and low-lying land surrounding it there is the Tidal River Tees flood alert area (code 121WAT926). The monitoring station for this area is the River Tees at Tees Dock, station ID 8372, located at the Teesport dock, 3km west of the site boundary.

There are no flood alleviation schemes within the site or affecting the small watercourses through the site. The closest scheme is the Port Clarence and Greatham South scheme, mentioned in section 2.5. These are designed to protect homes and businesses in Port Clarence.

3.2 Asset Design and Protection

The remediation activities are part of the overall proposals for the NZT site and so the lowering of the land to undertake this remediation will be temporary, with the final site ground levels to be located at 7.3mAOD, outwith the 200 year Coastal Flood Risk + Sea Level Rise Allowance to 2100 design scenario of 5.03m AOD.

However, during the excavation works during the remediation, the site is anticipated to be at increased risk of coastal and tidal flooding since it is below the 200 year Coastal Flood Risk + Sea Level Rise Allowance to 2100 design scenario. Surface water ponding and surface water flow pathways are also anticipated to be affected.

To mitigate for this increased flood risk, the site compound and any assets / vehicles involved with the remediation activities should be located outwith the functional floodplain when not in use for excavation or treatment.

There is a residual risk of groundwater flooding throughout the site however, this is expected to be limited to basements and other below ground structures where flood resilience will rely on the performance of waterproofing and pumping systems.

This assessment has been undertaken as a high level analysis of flood risk to the site. Analysis has been based on modelling and mapping of flood risk to the current site and a high level assessment of the likely flood risk which may result based on the indicative dig depths associated with the remediation activities. Further mapping and modelling of flood risk may be required as part of the reserved matters stage of the planning process.

3.3 Surface Water and Drainage Management

During the construction phase of the remediation, the Environment Agency and Pollution Prevention Guidance will have to be implemented and a Construction Stage Surface Water Management Plan ('SWMP') will be incorporated into the site so that run off can be carefully controlled using temporary drainage. In addition, measures will be included to reduce the risk of site pollution and contamination and details will be recorded of the soils, chemicals and oils used during the construction process, plant and machinery will be well maintained to reduce the risk of oil spillages or similar and an emergency response protocol will be developed by contractors so that any accidents of spillages are intercepted before material can seep into groundwater.

3.4 Safe Access and Egress

There are three egress routes available from the site: Tod Point Road which bounds the site to the north and two minor access roads to the east. It is understood that the primary access from the site will be via Steel House roundabout. The primary access road can be utilised during a flood event. If the primary access road is flooded, refuge can be access within the site while the emergency services are contacted. Large emergency vehicles may

be able to operate in flood depths of up to 0.9m[23], so in the instance of a large flood event, it is anticipated that emergency access would be possible to most of the site. Emergency access and egress routes shall be included as part of the site operations plan.

3.5 Potential Impact of the Proposed Development on Flood Risk Within and Outwith the Site

The proposed development is not anticipated to have an impact on flood risk outwith the site since the excavations are local to the site and so any lowering would result in increased flood risk to the site itself rather than the surrounding area. As described in the sections above, lowering the ground levels, does present an increased flood risk to the site itself, however there are no residential properties/buildings currently in use within the site or surrounding it. The risk is therefore associated with the remediation activities.

The site boundary at present is located at or greater than 20m from the Tees. An environmental permit is required for any activity that may pollute the air, water or land; increase flood risk; or adversely affect land drainage and work on or near main rivers requires a permit. The River Tees is designated as a main river but as the other watercourses (open and culverted) across the site are not main rivers, the EA guidelines advise contacting the local council or internal drainage board to check if land drainage consent is required. https://www.gov.uk/guidance/check-if-you-need-an-environmental-permit Permits are generally required for:

- Any activity within 8 metres of the bank of a main river, or 16 metres if it is a tidal main river,
- Any activity within 8 metres of any flood defence structure or culvert on a main river, or 16 metres on a tidal river.

Once the design for the site is developed, consultation should be undertaken with the Flood Risk Management Authorities.

23 Defra/Environment Agency Flood and Coastal Defence R&D Programme: R&D Outputs: Flood Risks to People, FD2321/TR2 Guidance Document, 2006.

4 Conclusions

This high level FRA has been prepared in accordance with NPPF for the proposed development that is part of the wider Teesworks area. The proposed development lies within Flood Zone 1 which means it has a chance of flooding of less than 0.1% - equivalent to the 1000-year event. In accordance with Planning Practice Guidance, the proposed development is considered to be less vulnerable, therefore is appropriate in Flood Zone 1, which is suitable for all types of development.

During the excavation for the remediation, the lowering of the land may increase the site's vulnerability to flood risk and so the contractor undertaking the excavation should take account of flood risk in the site operation plans and method statement.

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