

# **South Humber Bank Energy Centre Development Consent Order**

**South Marsh Road, Stallingborough, DN41 8BZ**

**Appendix 12A: Phase 1 Geo-environmental and Geotechnical Desk Study Report**



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**Applicant: EP Waste Management Limited  
Date: October 2019**

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## DOCUMENT HISTORY

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60580855.DS.001  
60580855.DS.002  
60580855.DS.003  
60580855.DS.004

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The methodology adopted and the sources of information used by AECOM in providing its services are outlined in this report. The work described in this report was undertaken between **[2nd July 2018]** and **[4<sup>th</sup> October 2019]** and is based on the conditions encountered and the information available during the said period of time. The scope of this report and the services are accordingly factually limited by these circumstances. AECOM disclaim any undertaking or obligation to advise any person of any change in any matter affecting the report, which may come or be brought to AECOM’s attention after the date of the report.

The opinions expressed in this report and the comments and recommendations given are based on a desk assessment of readily available information and an initial site reconnaissance by an AECOM Engineer. At this stage intrusive investigations have yet to be undertaken at site to establish actual ground and groundwater conditions and to provide data for an assessment of the geo-environmental status of the Site.

The site reconnaissance consisted of a general external inspection of the Site aimed at identifying any obvious signs of geotechnical hazards and potential sources of ground contamination affecting the Site. An environmental compliance audit and/or detailed structural inspection of existing buildings were outside the project brief. Similarly, the site visit excluded detailed consideration of the ecological or archaeological aspects of the Site, and if such are believed to be of potential significance then it is recommended that specialist advice is sought.

Any risks identified in this report are perceived risks, based on the information reviewed during the desk study and therefore partially based on conjecture from available information. The study is limited by the non-intrusive nature of the work and actual risks can only be assessed following a physical investigation of the Site.

Reference to historical Ordnance Survey (OS) maps and/or data provides invaluable information regarding the land use history of a site. However, it should be noted that historical evidence will be incomplete for the period pre-dating the first edition and between the release of successive maps and/or data.

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## 1.0 INTRODUCTION

### Purpose of Report

- 1.1 AECOM Infrastructure and Environment UK Ltd (hereafter referred to as AECOM) was commissioned in 2018 to undertake a Phase 1 Geo-environmental and Geotechnical Desk Study Report to support a planning application for the proposed South Humber Bank Energy Centre (the Consented Development) adjacent to the existing South Humber Bank Power Station. This Phase 1 Desk Study Report covers the Main Development Area to the east of the existing South Humber Bank Power Station and to the west of the Power Station's cooling water pumping station. The information contained within this Report is also directly relevant to the assessment of environmental impacts associated with the Proposed Development to accompany the Development Consent Order application.
- 1.2 This Phase 1 Report aims to identify any potential contamination issues from current and historic land uses, which may be related to on and off-site sources. This report will also provide a preliminary assessment of the geotechnical factors which have the potential to affect a future development. This Report reviews the existing information and proposals for the Site. This assessment encompasses the following:
- geological conditions;
  - hydrology and hydrogeology;
  - contaminated land assessment;
  - environmental risk assessment;
  - geotechnical assessment;
  - mining risk assessment;
  - ground gas risk assessment; and
  - outline ground investigation proposals.

### Methodology

- 1.3 The assessment presented in this Report and the recommendations provided have been prepared in accordance with the following guidance:
- British Standard BS 10175: A2 'Investigation of Potentially Contaminated Sites – Code of Practice' (2017);
  - Contaminated Land Report (CLR) 11 'Model Procedures for the Management of Land Contamination' (2004);
  - DEFRA Circular 01/2006 'Environment Protection Act 1990 Part 2A Contaminated Land' (2006); and
  - Environment Agency 'Groundwater Protection' Guide.
- 1.4 This Report considers the implications of Part 2A of the Environmental Protection Act 1990 and the associated Contaminated Land (England) Regulations 2006 and the Contaminated Land (England) (Amendment) Regulations 2012.
- 1.5 To achieve the stated objectives, the following tasks have been performed:
- a review of the geological, hydrological and hydrogeological setting across the Site, together with public domain geo-environmental information to build up an accurate understanding of the Site and surrounding environmental setting/ sensitivity;

- a review of historical land uses for the Site and surroundings with a particular emphasis on identifying potential ground hazards and potential on-site and off-site contamination sources;
- preparation of a conceptual site model with a view to identifying any significant source-pathway-receptor linkages followed by a qualitative risk assessment; and
- a review of potential geotechnical constraints.

### **Information Sources**

- 1.6 The following information sources have been used in the preparation of this assessment:
- British Geological Survey (BGS) 1:50,000 Series England and Wales Sheet 81, Patrington – Bedrock and Superficial Deposits map and memoir;
  - British Geological Survey (BGS) 1:10,560, Sheet TA21SW map;
  - BGS Open Geoscience, (<http://www.bgs.ac.uk/opengeoscience>) last accessed on 25<sup>th</sup> September 2019;
  - MAGIC website (<http://magic.defra.gov.uk>) accessed on 25<sup>th</sup> September 2019;
  - Envirocheck Report, Landmark Information Group, 14th June 2018, Order No. 169911223\_1\_1;
  - Environment Agency website ([www.gov.uk/government/organisations/environment-agency](http://www.gov.uk/government/organisations/environment-agency)), accessed on 25<sup>th</sup> September 2019; and
  - aerial photograph of South Humber Bank Power Station reproduced on 28<sup>th</sup> June 2018 with permission of EP SHB Ltd.

## 2.0 ENVIRONMENTAL SETTING

### Location

- 2.1 The Proposed Development Site (the Site), which incorporates the Main Development Area, is located off South Marsh Road, Stallingborough, North East Lincolnshire (see Figure 60580855/DS/001- Site Location Plan). The Site boundary and the Main Development Area are shown on Figure 60580855/DS/002.

### Site Layout and Context

- 2.2 The Site is currently vegetated and is generally level. Ground levels of the Site range between 2.0 m Above Ordnance Datum (AOD) and 2.9 m AOD (BGS Ordnance Survey Terrain 50 Digital Terrain Model, 16<sup>th</sup> August 2018). However, there are some hollows and hummocks across the Site. The surrounding land is also relatively level.

### Site Walkover

- 2.3 A site walkover was undertaken on 6th July 2018. Photographs from the site walkover are presented in Annex 1.
- 2.4 The Main Development Area occupies an area of circa 7 ha and comprised a vegetated area used as the route for the underground water-cooling pipes (connecting the two CCGT units and the cooling water pumping station) and associated access road.
- 2.5 The Main Development Area comprised grassland and the pumping station access road. In the north-east of the Main Development Area was a pond and some scattered scrubby vegetation and discrete sections of free-standing hedgerow. There was also a former attenuation pond within the south-west of the Main Development Area which was previously used as a settlement pond for commissioning purposes for South Humber Bank Power Station but at the time of the survey its levels were maintained naturally by surface water as the drainage pipes connected to it were redundant. Drainage ditches were present along the northern, eastern and southern perimeter of the Site. There were also a number of existing buried services associated with the existing South Humber Bank Power Station, within the Main Development Area.
- 2.6 A very small amount of concrete rubble was noted on the main grassed area, south of the central access road. It was considered likely that this, together with the hummocky ground related to the presence of materials arising from the construction of the South Humber Bank Power Station in the 1990s. Figure 60580855/DS/004 is an aerial photo taken in the 1990s which shows the Main Development Area to have been disturbed from activities associated with the construction of the power station and sub-surface cooling water pipelines. The photograph shows that these activities including stockpiling of topsoil and sub soil and use of the Main Development Area for construction laydown and a site compound.
- 2.7 Markers and open pipes protruding out of the ground crossed the Main Development Area following the routes of the cooling water pipes that ran beneath the Main Development Area between the power station and the pumping station and the intake and outfall points on the banks of the Humber Estuary.
- 2.8 The land was being used for grazing by sheep, but aside from this and the cooling water pumping station access road and the underlying utility and water connection routes, the Main Development Area was unused.

## Surrounding Land Uses

- 2.9 The Site is surrounded by the following land uses:
- to the north of the Site are agricultural fields and the premises of Synthomer (UK) Limited, suppliers of aqueous polymers; to the north of the Synthomer plant is the NEWLINCS Integrated Waste Management Facility;
  - to the immediate west of the Main Development Area is the existing South Humber Bank Power Station;
  - to the east of the Main Development Area are the South Humber Bank Power Station pumping station and the Humber Estuary; and
  - to the south of the Site are agricultural fields in arable use.

## Hydrology

- 2.10 The Humber Estuary lies to the east of the Site. ‘High Water Tide’ mark is noted on the OS maps as approximately 175 m from the eastern perimeter of the Main Development Area.
- 2.11 There is a system of drainage channels around the majority of the perimeter of the Site. The Oldfleet Drain is located approximately 320 m south of the Site.
- 2.12 As noted above, there were two surface water bodies (ponds) on the Site. These ponds have since been infilled in preparation for the construction of the Consented Development. A large pond lies off-site approximately 430 m south of the Site to the south of the Oldfleet Drain.
- 2.13 The Environment Agency Catchment Data Explorer (accessed online on 25<sup>th</sup> September 2019) indicates the north-eastern area of the Site is within the ‘North Beck Drain’ catchment area and the south-western area is within the ‘Mawbridge Drain’ catchment area. The chemical qualities of both catchments are classified as ‘Good’ in the 2016 classification, indicating the Water Framework Directive (WFD) objective has been met. The ecological qualities of both catchments are designated as ‘Moderate’ in the 2016 classification, with an objective of ‘Good’ classification set for 2027.
- 2.14 The Environment Agency flood map for planning (accessed online in 25<sup>th</sup> September 2019) indicates that the Main Development Area is within Flood Zone 3. These are areas 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. The flood zone does not take into account the presence of the flood defences in the area.

## Geology

- 2.15 Geological information on the Site was sourced from the following sources of online British Geological Survey (BGS) data © Natural Environment Research Council (NERC) [2019] at [www.bgs.ac.uk](http://www.bgs.ac.uk):
- BGS 1:50,000 Series England and Wales Sheet 81, Patrington – Bedrock and Superficial Deposits map;
  - BGS (1994) Geology of the country around Grimsby and Partington: memoir for 1:50,000 geological sheets 90 and 91 and 81 and 82 (England and Wales);
  - BGS 1:10,560 Ordnance Survey Sheet TA21SW;
  - Geology of Britain Viewer (accessed 25<sup>th</sup> September 2019); and
  - BGS Lexicon of Named Rock Units.

#### Made Ground

- 2.16 Made Ground is not recorded on the geological maps within the Main Development Area. However, the uneven surface of the Main Development Area and the presence of a mound, noted during the site walkover, may indicate the presence of Made Ground.
- 2.17 The BGS Solid and Drift Map Sheet TA21SW (1:10,560) identifies Made Ground to the immediate north/ north-east of the Main Development Area. The Made Ground is noted on the BGS map to comprise primarily chalk rubble and till, with a thickness of up to 0.75 m.

#### Superficial Deposits

- 2.18 The BGS Solid and Drift Map 1:50,000 and the Geology of Great Britain Viewer show the Site to be underlain by superficial deposits of Tidal Flat (Clay and Silt) deposits described by the BGS Lexicon as being “*normally a consolidated soft silty clay, with layers of sand, gravel and peat. Characteristically low relief; from the tidal zone.*” The BGS memoir indicates that that the Tidal Flat deposits are underlain by Glacial Deposits of Devensian age.

#### Bedrock Geology

- 2.19 The BGS Solid and Drift Map 1:50,000 and Geology of Britain Viewer show that the underlying bedrock is the Flamborough Chalk formation. The Flamborough Chalk formation is described by the BGS Lexicon as being “*White, well-bedded, flint-free chalk with common marl seams (typically about one per metre). Common stylolitic surfaces and pyrite nodules.*”
- 2.20 There are no geological faults identified at the Site on either the BGS 1:50,000 or 1:10,560 scale maps.

#### **BGS Borehole Records**

- 2.21 There are four BGS borehole records available within 250 m of the Site; one approximately 150 m west of the Site and three approximately 250 m west of the Site.
- 2.22 The four boreholes have been reviewed and a summary is presented in Table 2.1. The boreholes indicate that the Tidal Flat deposits comprise clayey and sandy silts and silty clays. The Glacial Deposits contain both clay and sand layers.

**Table 2.1: BGS Borehole Records**

BGS REFERENCE	DISTANCE FROM THE SITE	GEOLOGY (SUMMARY OF DESCRIPTIONS) (DEPTHS M BGL)
TA21SW119	150 m W	0.00 - 0.30 m: Made Ground 0.30 - 7.48 m: Mudflat Intertidal Channel comprising of layers of clayey silt, and sandy silts 7.48 – 9.00 m: Low Salt Marsh, comprising of silty clay with peat, wood fragments, pebbly sandy silt with chalk pebbles at base. No water strike recorded.
TA21SW347	250 m W	0.00 - 9.30 m: Alluvium 9.30 - 21.00 m: Glacial Deposits comprising of layers of clay and sand, 21.00 - 25.00 m (base of borehole): Flamborough Chalk

BGS REFERENCE	DISTANCE FROM THE SITE	GEOLOGY (SUMMARY OF DESCRIPTIONS) (DEPTHS M BGL)
		Water strike: 10.70 m
TA21SW346	250 m W	0.00 - 7.80 m: Alluvium 7.80 - 23.00 m: Glacial Deposits comprising of layers of clay and sand, 23.00 - 25.00 m (base of borehole): Flamborough Chalk Water strike: 11.40 m
TA21SW345	250 m W	0.00 - 6.60 m: Alluvium 6.60 - 21.30 m: Glacial Deposits comprising of layers of clay and sand, 21.30 - 25.00 m (base of borehole): Flamborough Chalk Water strike: 9.70 m

### Potential for Natural Ground Hazards

2.23 The following potential for Natural Ground Hazards have been identified for the Site (Envirocheck Report (Order No. 169911223\_1\_1)) (available on request):

- Potential for Collapsible Ground Stability Hazards – no hazard;
- Potential for Compressible Ground Stability Hazards – moderate to very low;
- Potential for Ground Dissolution Stability Hazards – no hazard;
- Potential for Landslide Ground Stability Hazards – very low;
- Potential for Running Sand Ground Stability Hazards – moderate to very low; and
- Potential for Shrinking or Swelling Clay Ground Stability Hazards – low.

### Mining

2.24 There are no BGS Recorded Mineral Sites within 1 km of the Site and it is not within an area affected by coal mining.

### Hydrogeology

2.25 The superficial deposits (Tidal Flats overlying Glacial Deposits) at the Main Development Area are designated as an Unproductive Aquifer by the Environment Agency (<https://magic.defra.gov.uk> accessed 25<sup>th</sup> September 2019).

2.26 The underlying bedrock at the Site (Flamborough Chalk) is designated by the Environment Agency as a Principal Aquifer. Principal Aquifers exhibit high permeability and/or provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

2.27 The Site is not located within a groundwater Source Protection Zone and there are no groundwater abstractions within 1 km of the Site.

### Previous Ground Investigation

2.28 In 2006, Centrica, the then owner and operator of South Humber Bank Power Station commissioned the design of a Site Protection and Monitoring Program for South Humber Bank Power Station in support of the Site's Environmental Permit application. A ground investigation was undertaken, and monitoring wells were installed in the western part of the Site. The following assessment from the ground investigation is based on the

document ‘Site Protection and Monitoring Programme Review for South Humber Bank Power Station’; September 2011 which is a review and summary and does not contain factual information from the ground investigation.

- 2.29 The intrusive ground investigation recorded variable thicknesses of Made Ground overlying superficial alluvial clay deposits comprising very soft or soft black to grey brown or dark grey clay with a slight organic reducing odour. The alluvial clay was observed as becoming very sandy at 4.0 m bgl with groundwater seepages.
- 2.30 During the ground investigation groundwater was encountered across the monitoring well network with resting groundwater depths ranging from 0.22 m below casing top (bct) to 1.55 m bct. It was inferred from this monitoring that the direction of shallow groundwater flow was towards the southeast.
- 2.31 Results of chemical analysis of the shallow soils reported that the presence of localised, trace concentrations of heavy fractions ( $C_{21} - C_{25}$ ) aromatic and aliphatic total petroleum hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAHs).
- 2.32 Results of groundwater chemical analysis results reported, recorded TPH concentrations below the method detection limits and aqueous PAH concentrations of 0.129 µg/l and 0.29 µg/l. It was noted that the groundwater pH and chloride concentrations suggested alkaline freshwater conditions beneath the site, with no evidence of saline intrusion from the Humber Estuary.

### Review of Historical Ordnance Survey Maps

- 2.33 Historical mapping has been reviewed to assess the potential for past activities, both on and adjacent to the Main Development Area, which may have impacted upon the Site’s environmental and land quality. Historical Ordnance Survey (OS) maps of the Site were obtained as part of the Envirocheck report (169911223\_1\_1). The maps are dated from 1887 to 2018. The maps are presented at scales of 1:10,560, 1:10,000, and 1:2,500.
- 2.34 The historical maps have been reviewed and features considered potentially relevant to the Site have been described in the sections below.

### Key Features – On Site

- 2.35 Table 3.1 presents a summary of the historical land uses at the Site. This table describes significant changes in industry and land use within the Site from 1887 to the present day. This overview of historical land use has an emphasis on land uses which could have contributed to land contamination. Table 2.2 describes the main features present on Site. Where dates are given, these refer to dates of maps on which the features appear, and do not necessarily refer to the exact date of operation of any particular facility.

**Table 2.2: Summary of Historic Mapping – On-site**

MAP SCALE / TYPE	DATE	ON-SITE LAND USE
1:10,560	1887 - 1888	Agricultural fields, with a drainage ditch parallel with the northern perimeter.
1:2,500	1888	No change
1:2,500	1907	No change
1:10,560	1908	No change
1:10,560	1932 - 1933	No change
1:2,500	1932	No change
1:10,560	1938 - 1951	No change
1:10,000	1956	No change
1:2,500	1965	No change

MAP SCALE / TYPE	DATE	ON-SITE LAND USE
1:10,000	1966	No change
1:10,000	1968	No change
1:2,500	1978	No change
1:10,000	1982	No change
1:10,000	1989	No change
1:2,500	1993	No change
1:2,500	1999	The South Humber Bank Power Station is now present on the western part of the Site, along with an attenuation pond in the southern area of the Site.
1:10,000	2000	No change
1:10,000	2006	A pond is now shown in the north-eastern corner of the Site.
1:2,500	2015	No change
1:10,000	2018	No change

**Key Features – Off Site (within 1 km)**

2.36 Table 2.3 presents a summary of the historical land uses off Site. This table describes significant development within 1 km of the Site from 1859 to the present day. This overview of historical land use has an emphasis on land uses which could have contributed to land contamination. The table describes the main features present in the vicinity of the Site. Where dates are given, these refer to dates of maps on which the features appear, and do not necessarily refer to the exact date of operation of any particular facility.

**Table 2.3: Summary of Historic Mapping – Off Site**

MAP SCALE / TYPE	DATE	OFF-SITE LAND USE
1:10,560	1887 – 1888	The Humber Estuary lies to the east of the Site. High water tide mark is noted approx. 175 m east and low water tide mark is noted approx. 400 m east. The surrounding area is predominantly agricultural fields. There is a drainage channel approx. 400 m north of the Site and Oldfleet Drain is shown approx. 300 m south of the south. Several foot bridges exist over the drainage channels. A spring is shown approx. 900 m south of the Site. Two beacons are present north of the Site, one approx. 300 m and the other along the high tide mark at approx. 480 m. An orchard is located approx. 800 m south of the Site.
1:10,560	1908	The beacons are no longer present. A spring is shown approx. 380 m north of the Site.
1:2,500	1907	A sheep pen is present outside the north-western boundary of the Site.
1:10,560	1932 - 1933	The low water tide mark is now shown at approx. 400 m east of the Site; high water tide mark remains the same. The Grimsby District Electric Light Railway is present approx. 600 m west of the Site boundary. A rifle range is shown approx. 1 km south-east of the Site.
1:10,560	1938 - 1951	No change
1:10,000	1956	No changes apart from two springs are now shown, one approx. 490 m south-west of the Site. The other approx. 850 m south-west of the Site.
1:2,500	1965	Works buildings are present on the outskirts of the north-east boundary.
1:10,000	1966	Works buildings are now present between 500 m to 1 km south-east of the Site.
1:10,000	1968	Works are now present on the north-east perimeter corner outside the Site. To the west of these works within the 250 m boundary there are nine unidentified features which may be concrete bases. A pipeline is shown between 500 m and 1 km south-east of the Site and the works buildings in this area have increased since 1966.

MAP SCALE / TYPE	DATE	OFF-SITE LAND USE
1:2,500	1978	Further development of the works on the outskirts of the north-east boundary and further development on the outskirts of the eastern boundary of the Site
1:10,000	1982	The works on the north-east corner of the Site have been extended and the works buildings in the south-east corner between 500 m and 1 km have extended beyond 1 km.
1:10,000	1989	No change
1:10,000	2000	The South Humber Bank Power Station is now present in the western part of the Site. A Pump Works (the Power Station's cooling water pumping station) is present to the east of the Site on the banks of the Humber Estuary. Further works have developed between 500 m and 1 km north-west of the Site. Road infrastructure is now presented showing South Marsh Road which runs parallel with the perimeter of the northern boundary of the Site. The works buildings to the south-west which previously were present between 500 m and extending beyond 1 km has extended further has buildings closer to the south-east Site at approx. 400 m.
1:10,000	2006	A pipeline is shown approx. 270 m from the eastern boundary of the Site extending from the headland towards the sea.

### **3.0 SUMMARY OF ENVIRONMENTAL INFORMATION**

- 3.1 Site sensitivity datasheet and maps have been obtained using an Envirocheck report (available on request). Environmental features considered potentially relevant to the Site have been summarised in the following sections. The search radius is generally limited to 1 km from the Site, unless otherwise stated.

#### **Discharge Consents**

- 3.2 Discharge consents in the vicinity of the Site are summarised in Table 3.1.

**Table 3.1: Discharge Consents within 1 km**

DISTANCE FROM SITE	DESCRIPTION
On-Site	None
0-250 m	None
250–500 m	There are two discharge consents 350 m north-east of the Site held by Doverstrand Limited. One is for trade discharge/ process water, discharging to Humber Estuary and the other is for trade effluent discharging to the Stallingborough Drain. A discharge consent, located 476 m west of the Site, is held by Katoe Native Immingham Limited for sewage discharges, discharging to a tributary of Middle Drain
500 m-1 km	There is a discharge consent 597 m north-east of the Site held by Harlow Chemical Co Limited for trade discharge, process water, discharging to the Humber Estuary. A discharge consent is held by BOC at 748 m west of the Site for trade discharge of process water, sewage discharge of final/ treated effluent and discharge of surface water, all discharging to Middle Drain. Courtaulds Fibres Limited hold two discharge consents: one is located 776 m east of the Site for trade effluent and the other is located 981 m east of the Site for process water and trade effluent all discharging to the Humber Estuary.

#### **Water Abstractions**

- 3.3 Water abstractions in the vicinity of the Site are summarised in Table 3.2.

**Table 3.2: Water abstraction within 1 km.**

DISTANCE FROM SITE	DESCRIPTION
On-Site	None
0-250 m	None
250–500 m	None
500 m-1 km	There is one entry which relates to a surface water abstraction from a stream 610 m east of the Site for cooling, licensed to Humberland Limited. Another entry relates to a surface water abstraction from Old Fleet Drain for environmental use by North East Lincolnshire Council.
1 – 2 km	Twelve groundwater abstraction entries are listed; eleven for process water; one for general farming/ domestic use. One surface water abstraction entry is listed for environmental purposes; and one tidal source abstraction entry is listed for the production of energy.

- 3.4 There are no potable water abstractions listed within 2 km of the Site.

### Pollution Incidents to Controlled Waters

- 3.5 Sixteen pollution incidents to controlled waters have been reported located within 500 m of the Site, according to the Envirocheck report. The details for these pollution incidents are provided in Table 3.3.
- 3.6 Five locations are reported between 500 m and 1 km of the Site (four south-east and one west). It is noted that two category 2 significant incidents have been recorded 554 m west and 789 m south-east of the Site, relating to unknown pollution found in the Middle Drain and the Humber Estuary, respectively.

**Table 3.3: Pollution Incidents to Controlled Waters**

APPROXIMATE DISTANCE	DATE	POLLUTANT	RECEIVING WATER	SEVERITY
9 m north-east	11/05/1995	Chemicals – other organic	Freshwater stream/ river	Category 3 – Minor incident
74 m north-east	30/03/1995	Chemicals – paints/dyes	Unnamed watercourse	Category 3 – Minor incident
90 m north	18/11/1994	Chemicals – unknown	Humber Estuary	Category 3 – Minor incident
91 m north	26/05/1994	Chemicals – unknown	Humber Estuary	Category 3 – Minor incident
95 m north	21/01/1995	Chemicals – paints/dyes	Freshwater stream/ river	Category 3 – Minor incident
96 m north	18/04/1993	Unknown	Humber Estuary	Category 3 – Minor incident
182 m south	04/05/1993	Unknown	Storm drain	Category 3 – Minor incident
195 m north	18/03/1996	Chemicals – other organic	Unnamed ditch	Category 3 – Minor incident
251 m east	11/10/1994	Oils – other fuel oil	Unnamed ditch	Category 3 – Minor incident
253 m east	18/02/1993	Unknown	Unnamed drainage ditch	Category 3 – Minor incident
271 m north-east	02/03/1993	Unknown	Unnamed tributary of Middle Drain	Category 3 – Minor incident
281 m north-east	03/01/1996	Chemicals – other inorganic	Middle Drain	Category 3 – Minor incident
298 m north-east	05/11/1992	Unknown	Unnamed drainage ditch	Category 3 – Minor incident

APPROXIMATE DISTANCE	DATE	POLLUTANT	RECEIVING WATER	SEVERITY
324 m north-west	09/09/1994	Chemicals – other organic	Tributary of Middle Drain	Category 3 – Minor incident
418 m north	11/04/1994	Chemicals – other organic	Middle Drain	Category 3 – Minor incident
423 m north	05/01/1993	Unknown	Middle Drain	Category 3 – Minor incident

#### Local Authority Pollution Prevention and Controls

- 3.7 There are two entries on the Site and one entry within 1 km of the Site, noted in the Envirocheck Report. The two entries on the Site both relate Local Authority Air Pollution Control (status: transferred to IPPC). The one entry within 1 km of the Site relates to The Control of Industrial Air Pollution (Registration of Works) Regulations 1989 (status: Authorisation revoked).

#### Substantiated Pollution Incident Register

- 3.8 One entry is shown within 1 km of the Site, according to the Envirocheck report. The details for this entry are provided in Table 3.4.

**Table 3.4: Pollution Incidents to Controlled Waters**

APPROXIMATE DISTANCE	DATE	POLLUTANT	WATER IMPACT	AIR IMPACT	LAND IMPACT
614 m east	22/09/07	Specific waste material	Category 4 – No impact	Category 4 – No impact	Category 2 – Significant Incident

#### **Industrial Land Use**

- 3.9 Contemporary trade land uses within the Site and in the vicinity of the Site are summarised in Table 3.5.

**Table 3.5: Contemporary Trade Land Uses**

DISTANCE FROM THE SITE	DESCRIPTION
On-site	Two entries; one classified as a waste disposal service and the other a power transmission service. Both entries are listed as active
0 – 250 m	Two entries; one classified as a rubber and plastic products manufacturer, which is active, and the other a chemicals and allied products manufacturer which is listed as inactive
250 – 500 m	None
500 m – 1 km	Two entries; one classified as a Recycling Centre and the other as a Gas Supplier. Both entries are listed as active.

- 3.10 There are no fuel station entries recorded within 1 km of the Site.

- 
- 3.11 Two points of interest for commercial services are listed on the Site, relating to vehicle repair and servicing.
  - 3.12 Three points of interest for manufacturing and production are listed. Between 0 m and 250 m 92 points are listed, seven are listed between 251 m and 500 m, and fifteen are listed between 500 m and 1 km. All the points of interest relate to unspecified works or factories.
  - 3.13 One point of interest for public infrastructure is listed within 1 km of the Site, relating to a sluice approximately 686 m east of the Site.
  - 3.14 There is one gas pipeline on the Site relating to 'FM09 - Brocklesby to Stallingborough PS' (Stallingborough PS' refers to South Humber Bank Power Station).

### **Waste**

- 3.15 No landfill sites or waste management facilities are listed within 250 m of the Site. However, there is one Permitted Waste Management Facility (NEWLINCS) located between 250 m and 500 m which is an energy from waste facility and a materials recovery facility.
- 3.16 There are seven Permitted Waste Management Facilities located between 500 m and 1 km of the Site.
- 3.17 One BGS Recorded Landfill site is located 825 m south-east of the Site.
- 3.18 Four Historic Landfills are listed between 500 m to 1 km south-east of the Site.

### **Potentially Infilled Land**

- 3.19 There are no areas of infilled land (non-water) recorded within 1 km of the Site.
- 3.20 Seven areas of infilled land (water) of unknown filled ground (pond, marsh, river stream dock etc.) are noted in the Envirocheck report. One of the infilled land (water) areas is listed between 0 m and 250 m and the remaining six are listed between 500 m and 1 km.

### **Radon**

- 3.21 The Site and surrounding area within 1 km is not in a radon area.

### **Sensitive Land Uses**

- 3.22 The Site is located in a Nitrate Vulnerable Zone.
- 3.23 The Humber Estuary is classified as a Ramsar site, a Site of Special Scientific Interest, a Special Protection Area and a Special Area of Conservation.

## 4.0 CONCEPTUAL SITE MODEL

- 4.1 Current legislation relating to contaminated land in the UK is contained within Part 2A of the Environmental Protection Act 1990, inserted by Section 57 of the Environment Act 1995, and by Section 86 of the Water Act 2003, and elaborated within the Contaminated Land (England) Regulations 2006 [S.I. 2006/1380] (amended 2012 [S.I. 2012/263]).
- 4.2 The “suitable for use” approach is adopted for the assessment of contaminated land where remedial measures are only undertaken where unacceptable risks to human health or the environment are realised taking into account the use, or proposed use, of the land in question and the environmental setting.
- 4.3 Current best practice recommends that the determination of health hazards due to contaminated land is based on the principle of risk assessment, as outlined in Part 2A of the Environmental Protection Act 1990.
- 4.4 The risk assessment process for the environmental contaminants is based on a source-pathway-receptor analysis. These terms can be defined as follows:
- Source: Hazardous substance that has the potential to cause adverse impacts;
- Pathway: Route whereby a hazardous substance may come into contact with the receptor: examples include ingestion of contaminated soil and leaching of contaminants from soil into watercourses; and
- Receptor: Target that may be affected by contamination: examples include human occupants/users of site, water resources (surface waters or groundwater), or structures.
- 4.5 For a risk to be present there must be a viable pollutant linkage i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway.
- 4.6 A conceptual site model has been developed for the Site and is presented in pictorial form on drawing 60580855/DS/003. The following sections detail the conceptual site model with the view to assessing the potential risks during construction and upon completion of the proposed new development. The potential sources of contamination, potential receptors and potential pollutant pathways are identified, and are presented in Tables 4.1 to 4.3, for the Site. The associated pollutant linkages between these sources, pathways and receptors are presented in Table 4.4.

### Sources of Potential Contamination

- 4.7 Table 4.1 lists sources of potential contamination at the Site.

**Table 4.1: Description of Potential Sources**

POTENTIAL SOURCE	DESCRIPTION
Made Ground	<p>According to the Department of Environment (DOE) (1995) Industry Profile, potential contaminant from power stations include polychlorinated biphenyls, chlorinated hydrocarbons (degreasing oils) methyl alcohol, ethylene glycol, diethylene glycol, triethylene glycol, synthetic resins, alkanolamine, and heavy absorption oils).</p> <p>During the site walkover a mound of possible made ground was identified. Made Ground has been identified on the western side of the Site at the South Humber Bank Power Station. Additionally Made Ground has been identified on the BGS Geoindex outside the north and north-eastern corner of the Site perimeter. The industrial use of the Site indicates the potential for contamination to be present within Made Ground at the Site.</p>
Natural strata	Natural strata may be a potential source if there has been any migration of contamination from the South Humber Bank Power Station into groundwater. The natural strata consists of Tidal Flat Deposits underlain by Glacial Deposits overlying bedrock of Flamborough Chalk.
Soil leachate	Potential contaminants may be leached from Made Ground, if determined to be contaminated, around the Site perimeter.
Groundwater	Perched/ shallow groundwater may be contaminated if shallow leachable contamination is present and/ or spillages or leakages have occurred at the Site.
Ground gas	Concentrations of ground gases (methane and carbon dioxide) could originate either from Made Ground (if it contains putrescible materials) or naturally organic content within the underlying Tidal Flat Deposits. The underlying bedrock may be a source of low concentrations of carbon dioxide.
Off Site sources	Leaks spills and emissions from surrounding sources e.g. industrial operations/ sites to the north and north-east of the Site.

### **Potential Receptors**

4.8 Table 4.2 lists receptors of potential contamination at the Site:

**Table 4.2: Description of Potential Receptors**

POTENTIAL RECEPtors	DESCRIPTION
Future Site users	The proposed future land use is an energy from waste power plant; therefore the future Site users would be workers and visitors of the Proposed Development.
Controlled waters	The main controlled waters receptor is considered to be the drainage channels around the Site which connect to the Oldfleet Drain in the south and the Middle Drain in the north which eventually outflow to the Humber Estuary  The underlying Principal Aquifer is also considered to be a potential receptor if there are pathways present within the superficial deposits.
Development infrastructure	The structural integrity of concrete may be affected by aggressive groundwater associated with soils with a low pH and high sulphate concentrations. Pyritic nodules are noted to be present within the Flamborough Chalk formation.
Construction/ maintenance workers	Construction and maintenance workers can be subjected to high levels of exposure to contaminated materials but over a short period of time in comparison with future Site users.
Off Site (human) receptors	This includes commercial/ industrial workers in the surrounding area.
Flora and Fauna	On Site flora and fauna may be affected by the presence of elevated concentrations of certain determinants. The Main Development Area was being used as a pastureland at the time of the site walkover survey.

### Potential Pathways

4.9 Table 4.3 lists pathways of potential contamination at the Site:

**Table 4.3: Description of Potential Pathways**

POTENTIAL PATHWAY	DESCRIPTION	
<b>Soil Pathways</b> Including the following sources: <ul style="list-style-type: none"><li>• Made Ground; and</li><li>• soil derived leachate</li></ul>	Dermal contact	Dermal contact with contaminated soils, soil derived dust, soil leachate and perched groundwater (if present).
	Direct contact	Direct contact of building materials with contaminated soils, soil leachate and perched groundwater (if present).
	Ingestion	Direct or indirect ingestion of soil and soil derived dust (if present).

POTENTIAL PATHWAY	DESCRIPTION	
	Inhalation	Inhalation of soil derived dust, organic vapours or ground generated gas (if present).
<b>Groundwater Pathways</b>  Including the following sources: <ul style="list-style-type: none"><li>• soil leachate; and</li><li>• perched groundwater</li></ul>	Rainfall infiltration and vertical/ lateral migration via permeable strata and service conduits	Rainfall infiltration can generate and mobilise soil-derived leachate impacting on surface waters and groundwater (if present).
	Lateral migration through aquifer	As well as being a receptor, aquifers allow transportation of contaminants through the permeable strata (if present).
<b>Gas Pathways</b>  Including the following sources: <ul style="list-style-type: none"><li>• ground gas.</li></ul>	Vertical/ lateral migration via permeable strata	Permeable strata and service trenches may allow transportation of ground gases (if present).

### Potential Pollutant Linkages

4.10 The potential pollutant linkages and associated risks identified for the Site in its proposed use are summarised in Table 4.4. The presence or absence of potential sources will be confirmed by ground investigation and chemical analysis of soil and groundwater samples.

**Table 4.4: Description of Potential Linkages**

POTENTIAL SOURCE	POTENTIAL PATHWAY	POTENTIAL RECEPTOR
Diffuse metal, inorganic and organic contamination within the Made Ground at the Site and from off Site sources (if present).	Ingestion of contaminated soil Inhalation/ ingestion of soil derived dust Inhalation of organic vapours Direct contact with soils/ dusts	Future Site users Construction/ maintenance workers Development infrastructure Flora and fauna Off Site receptors
Asbestos containing materials (ACM) within the Made Ground (if present)	Inhalation of soil derived dust Direct contact with soils/ dusts	Future Site users Construction/ maintenance workers Off Site receptors
Generated leachate from Made Ground and spills/ leaks into natural ground (if present)	Leaching into groundwater and migration to surface watercourses Plant uptake	Surface watercourses Perched groundwater Off Site flora and fauna

POTENTIAL SOURCE	POTENTIAL PATHWAY	POTENTIAL RECEPTOR
Contaminants in groundwater (e.g. from on or off Site spills and leaks) (if present)	Migration and diffusion	Middle Drain and Oldfleet Drain Shallow groundwater (in Principal Aquifer)
Ground gases (if present)	Migration and diffusion via permeable strata	Future Site users Construction/maintenance workers Flora and fauna Development infrastructure Off Site receptors

## 5.0 PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT

### General

- 5.1 From information obtained for the desk study, a conceptual site model was developed for the Site, as detailed in Section 4. Based on the subsequent risk assessment, the various components of the model are discussed in the following sections and take into account the Site in its current condition and potential future use as an industrial development. A preliminary assessment of the various pollutant linkages is presented in Table 4.4. A full assessment cannot be made until the results of a ground investigation; including chemical sampling of soil and groundwater sampling, are available. The proposed ground investigation is summarised in Section 8.

### Risk Assessment Principles

- 5.2 Current best practice recommends that the determination of hazards due to contaminated land is based on the principle of risk assessment, as outlined in Part 2A of the Environmental Protection Act 1990.
- 5.3 For a risk to be present, there must be a viable pollutant linkage; i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway. The potential pollutant linkages that have been identified for this Site are presented in Section 4.
- 5.4 Assessments of risks associated with each of these pollutant linkages, following review of available information for the Site is discussed in the following sections.
- 5.5 Using criteria broadly based on those presented in Section 6.3 of the CIRIA Report "Contaminated Land Risk Assessment: A Guide to Good Practice" (CIRIA Report C552) the magnitude of the risk associated with potential contamination at the Site has been assessed.
- 5.6 To do this an estimate is made of:
- the potential severity of the risk; and
  - the likelihood of the risk occurring
- 5.7 The severity of the risk is classified according to the criteria in Table 5.1.

**Table 5.1: Severity of Risk**

SEVERITY	DESCRIPTIONS
<b>Severe</b>	Acute risks to human health likely to result in "significant harm" (e.g. very high concentrations of contaminants/ ground gases) Catastrophic damage to buildings/ property (e.g. by explosion, sites with high gassing potential, extensive VOC contamination) Major pollution of controlled waters (e.g. surface watercourses or Principal aquifers/ source protection zones) Short term risk to a particular ecosystem
<b>Medium</b>	Chronic (long-term) risk to human health likely to result in "significant harm" (e.g. elevated concentration of contaminants/ ground gases) Pollution of sensitive controlled waters (e.g. surface watercourses or Principal/ Secondary aquifers) Significant effects on sensitive ecosystems or species
<b>Mild</b>	Pollution of non-sensitive waters (e.g. smaller surface watercourses or Unproductive Strata)

SEVERITY	DESCRIPTIONS
	Significant damage to crops, buildings, structures or services (e.g. by explosion, sites with medium gassing potential, elevated concentrations of contaminants)
<b>Minor</b>	Non-permanent human health effects (requirement for protective equipment during site works to mitigate health effects) Damage to non-sensitive ecosystems or species Minor (easily repairable) damage to buildings, structures or services (e.g. by explosion, sites with low gassing potential)

- 5.8 The probability of the risk occurring is classified according to criteria given in Table 5.2.

**Table 5.2: Probability of Risk Occurring**

PROBABILITY	DESCRIPTION
<b>High likelihood</b>	Pollutant linkage may be present that appears very likely in the short-term and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor
<b>Likely</b>	Pollutant linkage may be present, and it is probable that the risk will occur over the long term
<b>Low likelihood</b>	Pollutant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
<b>Unlikely</b>	Pollutant linkage may be present but the circumstances under which harm would occur even in the long-term are improbable.

- 5.9 An overall evaluation of the level of risk is gained from a combination of the severity and probability, as shown in Table 5.3.

**Table 5.3: Level of Risk**

PROBABILITY	SEVERITY				
	Severe	Medium	Mild	Minor	
<b>High Likelihood</b>	Very High	High	Moderate	Moderate/ Low	
<b>Likely</b>	High	Moderate	Moderate/ Low	Low	
<b>Low Likelihood</b>	Moderate	Moderate/ Low	Low	Very Low	
<b>Unlikely</b>	Moderate/ Low	Low	Very Low	Very Low	

### Evaluation of Risk

- 5.10 An evaluation of the potential risks associated with the identified sources at the Site to the various receptors is discussed and presented in the following section. The level of risk is determined based on the current condition of the Site (i.e. the effects of mitigation measures are not included) and takes into account the Main Development Area.
- 5.11 The evaluation includes an assessment of the significance of the potential pollutant linkages. Where it is considered that a particular pollutant linkage is not plausible in the context of the Site and the Main Development Area, the overall risk is determined as very low.

- 5.12 It should be noted that this risk assessment is an iterative process and is currently based on available desk top information. A ground investigation is being undertaken to obtain data on ground conditions and quality to allow refinement of the risk assessment. Where, following the ground investigation and reporting stage, all risks are identified as not requiring further investigation the process will end. Where potential pollutant linkages are confirmed to be present on Site then remedial works may be required.

## 6.0 GENERAL RISK ASSESSMENT

**Table 6.1: Risk Evaluation of Potential Pollutant Linkages**

SOURCE	PATHWAY	RECEPTOR	POTENTIAL POLLUTANT LINKAGE	RISK EVALUATION		
				SEVERITY	PROBABILITY	RISK
Contaminants in Made Ground/natural strata	Direct contact/ingestion/inhalation	Future Site users	Y	Mild	Low likelihood	Low
	Direct contact/ingestion/inhalation	Construction/maintenance workers	Y	Mild	Likely	Moderate/ Low
	Infiltration/migration	Controlled waters	Y	Medium	Likely	Moderate
	Direct contact	Development infrastructure	Y	Medium	Likely	Moderate
	Inhalation of vapours/dusts	Off Site receptors	Y	Minor	Low likelihood	Very Low
	Direct contact/uptake	Flora and fauna	Y	Minor	Low likelihood	Very Low

SOURCE	PATHWAY	RECEPTOR	POTENTIAL POLLUTANT LINKAGE	RISK EVALUATION		
				SEVERITY	PROBABILITY	RISK
Contaminants in leachate / groundwater	Direct contact/ ingestion / inhalation	Future Site users	Y	Mild	Low Likelihood	Low
	Direct contact/ ingestion/ inhalation	Construction/ maintenance workers	Y	Mild	Likely	Moderate / Low
	Infiltration/ migration	Controlled waters	Y	Medium	High likelihood	High
	Direct contact	Development infrastructure	Y	Medium	Likely	Moderate
	Infiltration/ off Site migration	Off Site receptors	Y	Medium	Low likelihood	Moderate / Low
	Direct contact / uptake	Flora and fauna	Y	Minor	Likely	Low
Ground gases	Migration and inhalation/ explosion	Future Site users	Y	Mild	Likely	Moderate/ Low

SOURCE	PATHWAY	RECEPTOR	POTENTIAL POLLUTANT LINKAGE	RISK EVALUATION		
				SEVERITY	PROBABILITY	RISK
	Migration and inhalation/ explosion	Construction/ maintenance workers	Y	Mild	Likely	Moderate/ Low
	Migration and explosion	Development infrastructure	Y	Minor	Likely	Low
	Migration and inhalation/ explosion	Off Site receptors	Y	Minor	Low likelihood	Very Low
	Direct contact/ uptake	Flora and fauna	Y	Minor	Likely	Low

### Evaluation of Risks to Future Site Users

- 6.1 There is a low likelihood that future Site users will come into contact with underlying soils therefore the risk is classed as low.
- 6.2 Future Site users could come into direct contact with the underlying soils in areas of landscaping around the Proposed Development.
- 6.3 There is potential for ground gas to be sourced from the Made Ground materials around the Site. Pathways for gas migration are likely to be present as the overburden backfill is likely to contain a variety of cohesive and granular materials, which will have a variety of permeabilities. This could introduce a considerable variation across the Site as to where ground gas could migrate to the surface.

### Evaluation of Risks to Controlled Waters

- 6.4 The potential risks to controlled waters are considered to be moderate to high if unmitigated. There are a number of drainage channels surrounding the Site and two surface water features within the Main Development Area which are most likely to be the most significant receptors. Additionally the Site overlies a Principal Aquifer of the Flamborough Chalk Formation.
- 6.5 There is also considered to be potential for contaminants to leach from the made ground into the drainage channels around the Site, which could migrate into nearby surface water features and groundwater.

### Evaluation of Risks to Development Infrastructure

- 6.6 The risks to the development infrastructure from soil, leachate and groundwater contaminants have been classed as moderate to low. It is assumed that any potential risks would be mitigated by using concrete and service pipes appropriate for aggressive ground conditions identified at the Site.
- 6.7 However, there is potential for ground gas to be sourced from the historic landfill sites to the south-east of the Site and the Made Ground materials around the Site and nearby industrial sites. It is anticipated that appropriate gas protection measures, where ground gas monitoring results indicate that protection is necessary, will be sufficient to mitigate this potential risk.

### Evaluation of Risks to Construction / Maintenance Workers

- 6.8 The assessment has identified a moderate/ low risk to construction/ maintenance workers at the Site. This takes into consideration that whilst construction/ Site workers might be expected to come into contact with soils, the use of personal protective equipment will be a pre-requisite to them being on the Site.
- 6.9 Prior to work commencing, a health and safety risk assessment should be carried out in accordance with current health and safety regulations. This assessment should cover potential risks to both construction staff and the local population. Based on the findings of this risk assessment, appropriate mitigation measures should be implemented during the course of the earthworks.
- 6.10 It is considered prudent that entry into excavations should comply with confined space legislation and assessed prior to entry.

### Evaluation of Risks to Off-Site (Human) Receptors

- 6.11 The potential risk to off Site human receptors is considered to be moderate/ low to very low.

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- 6.12 Potential risks to local off Site receptors would be associated with off Site migration of contamination, for instance, in the form of wind-blown dust and organic vapours. Exposure via inhalation of dust is considered to be negligible for off Site receptors following development works, and as such there is not considered to be a plausible pollutant linkage. The greatest potential for generation will be during the construction phase. Dust generation should be kept to a minimum in accordance with general best practice, as outlined in, for example, "Environmental Good Practice on Site", 3rd Edition, CIRIA Publication C692 and implemented and monitored on Site through a Construction Environmental Management Plan. Overall the risks to off Site receptors from on Site soil derived dusts are considered to be very low.
- 6.13 There is a moderate/ low risk to off Site receptors to infiltration from spills and leakages from refuelling of on Site fuel tanks and possible leakage services which run below the Site.

#### **Evaluation of Risks to on-site Flora and Fauna**

- 6.14 The risks to flora and fauna from the Proposed Development have been classified as low to very low. There is existing on Site flora and fauna that could be affected. Any future on Site flora will be dominated by planting introduced during landscaping and the species chosen will be suited to the Site environment. Suitably designed landscaping with sufficient depth of cover above any remaining deposits, possibly in conjunction with a separator layer, should be possible to mitigate any adverse effects that are identified through investigation.

## 7.0 PRELIMINARY GEOTECHNICAL REVIEW

### Depth to Rockhead

7.1 The superficial geology comprises Tidal Flat deposits overlying Glacial Deposits. BGS borehole records available for the west of the Site records depths to the Flamborough Chalk bedrock of around 21.0 m bgl.

### Weak and Compressible Ground

7.2 Historical maps show that from the 19th century, the Site was in continual use as agricultural fields until the development of the South Humber Bank Power Station. Made Ground left over from the construction of the Power Station is likely to be present across areas of the Site. Made Ground may also be present as fill around the underground cooling water pipelines which cross the Site from the Power Station to the Humber Estuary.

7.3 The main sources of geotechnical hazards are:

- potentially compressible natural ground materials (tidal flat deposits) present across the Site; and
- variable strengths of natural ground materials (including Tidal Flat deposits and Glacial Deposits).

### Buried Foundations

7.4 The likelihood of encountering unknown buried foundations is low, historical OS maps do not indicate development of any buildings or structures on the Main Development Area.

### Aggressive Ground Conditions

7.5 There are two types of aggressive ground conditions as summarised below.

- The first relates to natural sulphates that, in sufficient quantities, may be aggressive to concrete and steel causing degradation and damage. This can be overcome through the specification of more resistant concrete and anti-corrosion measures on steel, but requires testing and assessment of the soils beneath the Site in order to determine the level of risk. Common stylolitic surfaces and pyrite nodules are known to be present in the underlying Flamborough Chalk.
- The second area of potential for aggressive ground conditions relates to possible ground or groundwater contamination (if present). This can affect several areas of construction but an example is where chlorinated hydrocarbons are present in soil that can cause damage to plastic utility pipes. The potential exists for such compounds to have leaked or been spilled to isolated areas of the Site and will need to be considered in the design of proposed ground investigation works.

### Depth to groundwater

7.6 Groundwater has been recorded at shallow depth across the Site. Dewatering of excavations at the Main Development Area is likely to be required during construction and should be taken into consideration during the design of such works. A permit to discharge to surface water or consent to discharge to foul sewer may be required.

## 8.0 CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

- 8.1 This Phase I Geo-environmental and Geotechnical Desk Study has been carried out for the Proposed Development on land adjacent to the South Humber Bank Power Station.
- 8.2 From historical OS maps it can be seen that the Site has been in agricultural use since the late 19<sup>th</sup> century until the construction of the South Humber Bank Power Station in the western part of the Site in the mid-1990s.
- 8.3 A site walkover survey was carried out in July 2018. The Main Development Area was found to be predominantly flat and low lying, and adjacent to the Humber Estuary. Small amounts of concrete were visible on the Main Development Area but were thought to be remnants of construction waste rather than foundation material. Monitoring installations and route markers for electricity and cooling-water connections running between the pumping station to the east and the Power Station to the west were noted. The land was grassed and there were drainage ditches running along the northern, western and southern boundaries.
- 8.4 Geological mapping indicates that the Site is underlain by superficial geology of Tidal Flat Deposits and Glacial Deposits underlain by Flamborough Chalk bedrock. The superficial deposits are designated as an unproductive aquifer whilst the Flamborough Chalk is designated as a Principal Aquifer. The Site does not lie within a groundwater source protection zone.
- 8.5 A preliminary qualitative environmental risk assessment was carried out for the Main Development Area, based on the information obtained for the desk study. The proposed end use of the Site is industrial. The conclusions of the risk assessment are summarised below.
- The risks to future Site users are considered to be low. Potential future Site users could come into direct contact with the underlying soils in areas of landscaping around the Proposed Development. Furthermore there is potential for ground gas to be sourced from the Made Ground materials around the Site. Pathways for gas migration are likely to be present as the overburden backfill is likely to contain a variety of cohesive and granular materials, which will have a variety of permeabilities.
  - The risks to controlled waters are considered to be moderate to high, due to a number of drainage channels surrounding the Site which are likely to be the most significant receptors. Additionally the Site overlies a Principal Aquifer of the Flamborough Chalk Formation.
  - The risks to development infrastructure are considered to be moderate to low. It is assumed that any potential risks would be mitigated by using concrete and service pipes appropriate for aggressive ground conditions identified at the Site.
  - The risks to construction/ maintenance workers is considered to be moderate/ low and to off Site receptors are considered to be moderate/ low to very low.
  - The risks to potential on site flora and fauna are considered low to very low.
- 8.6 The main geotechnical uncertainties requiring investigation at the Main Development Area are considered to include:
- the depth to rockhead;
  - the potential compressibility of any Made Ground materials;
  - variable strengths of natural strata;

- potential aggressive ground conditions associated with made ground and Flamborough Chalk;
- the potential for shallow groundwater to be present;
- the presence of buried pipelines below the Site; and
- areas of uneven ground/ depressions;

### **Site Investigation**

- 8.7 Targeted ground investigation works are being undertaken in advance of construction of the Consented Development across the Main Development Area. The ground investigation aims to confirm the level of geo-environmental risk identified in this Report, and to provide preliminary geotechnical data to inform foundation design. The ground investigation aims to:
- investigate the nature and extent of Made Ground across the Main Development Area;
  - investigate the nature of the underlying natural strata, where present, including determination of in-situ soil properties, the natural bearing resistance of the overburden subsoil, porewater pressure, shear wave velocity, dynamic shear module and Poisson ratios;
  - investigate depths to rockhead;
  - obtain soil and groundwater samples for chemical testing and geotechnical testing;
  - install gas and groundwater monitoring wells and undertake monitoring of ground gas concentrations and groundwater levels; and
  - undertake a range of suitable soil, leachate and groundwater chemical tests, including Building Research Establishment (BRE) sulphate tests.
- 8.8 The ground investigation comprises cable percussion boreholes (with rotary core follow on into bedrock where appropriate) and standpipes for groundwater and ground gas monitoring, and machine-dug trial pits. Samples of soil, groundwater and surface water are also being obtained for chemical testing and geotechnical testing. The chemical testing will be undertaken for a range of suitable soil and groundwater chemical tests, including BRE sulphate tests.
- 8.9 Following the ground investigation, a factual and interpretative report will be prepared. This will include assessment and interpretation of ground conditions, geology, hydrogeology, contamination observations, in ground features and obstructions, geotechnical assessment and environmental risk assessment. The interpretative report will include an updated risk assessment based on the ground conditions encountered and the laboratory analysis undertaken.

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## **ANNEX 1: SITE WALKOVER PHOTOGRAPHS**

# Site Reconnaissance Photographs

**AECOM**



(1) Concrete / rubble



(2) Estuary from pump house



(3) Ground markers and inspection locations  
(buried pipework)



(4) Ground markers (buried pipework)



(5) Inspection location for buried pipeworks



(6) Hedges and hay

# Site Reconnaissance Photographs

**AECOM**



(7) Manufacturing site to the north



(8) Monitoring pipes



(9) Monitoring pipes



(10) North east pond



(11) North east pond



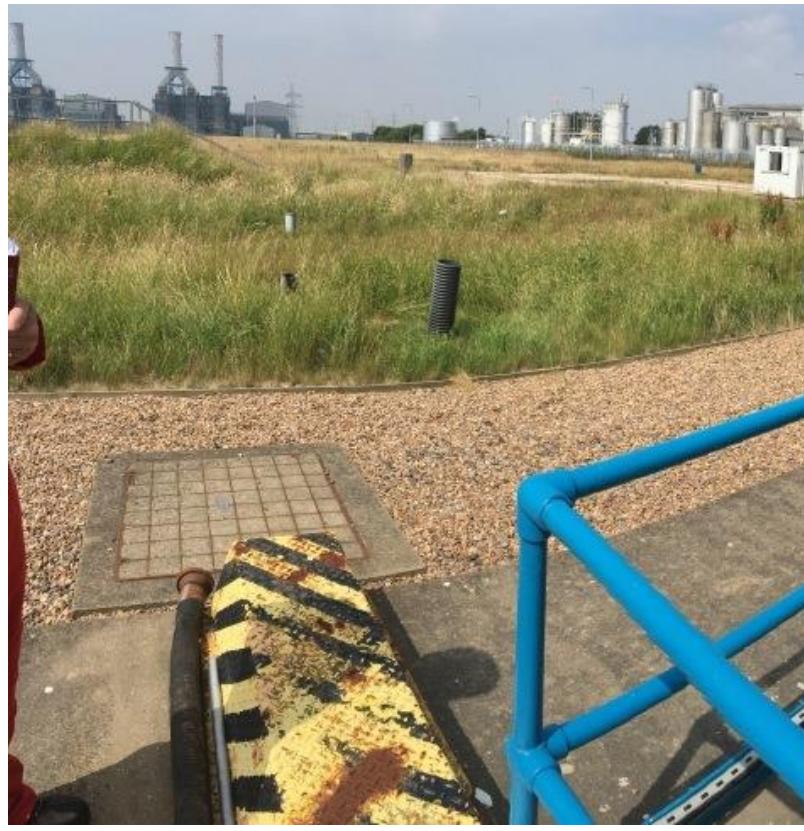
(12) Northern area of site

# Site Reconnaissance Photographs

**AECOM**



(13) Pump house water connection pipes



(14) Pump house water connection pipes



(15) Pump house water connection pipes



(16) Sheep grazing

# Site Reconnaissance Photographs

**AECOM**



(17) Sheep grazing



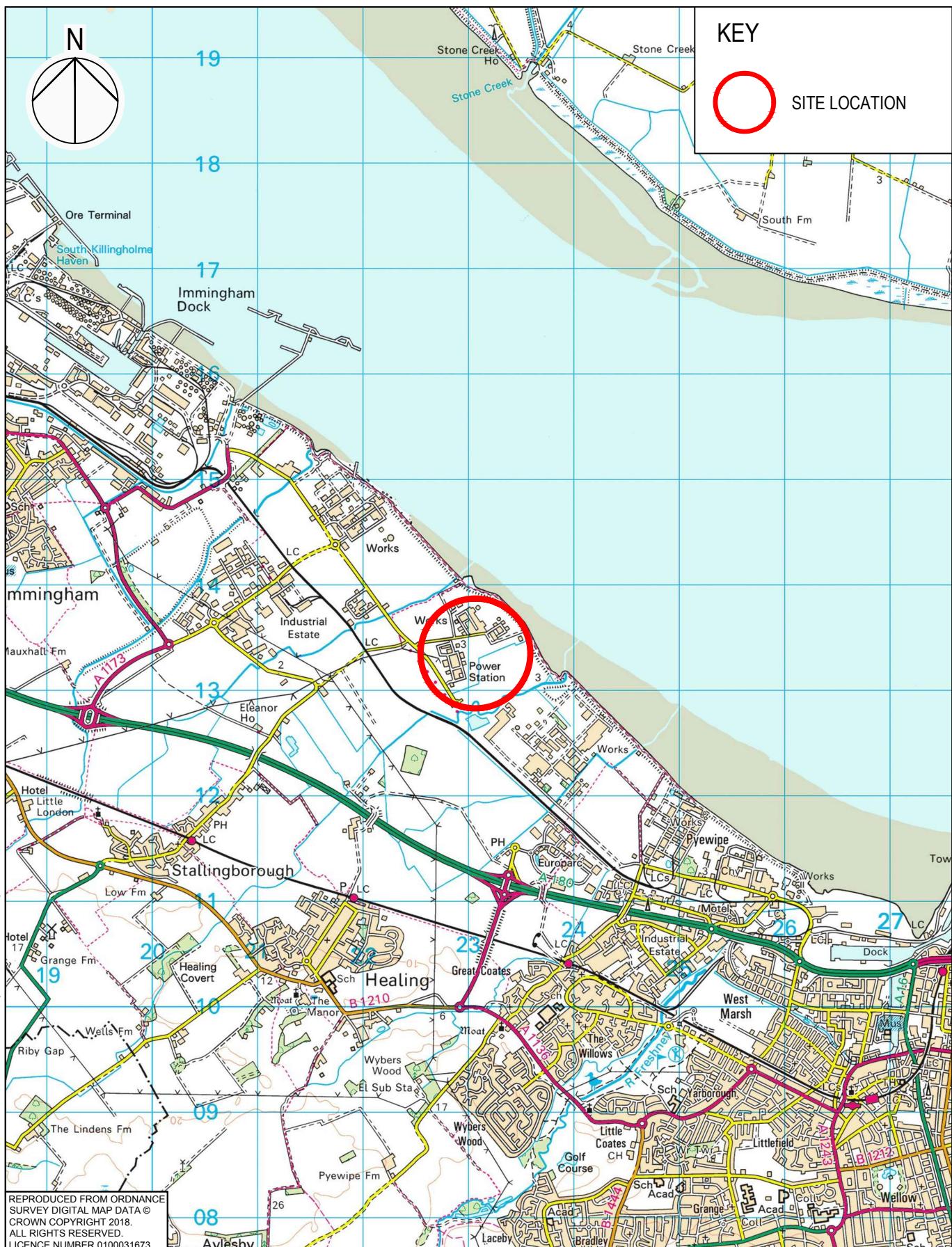
(18) Southern site area



(19) "Wetland" area and excavated munt



(20) "Wetland" area

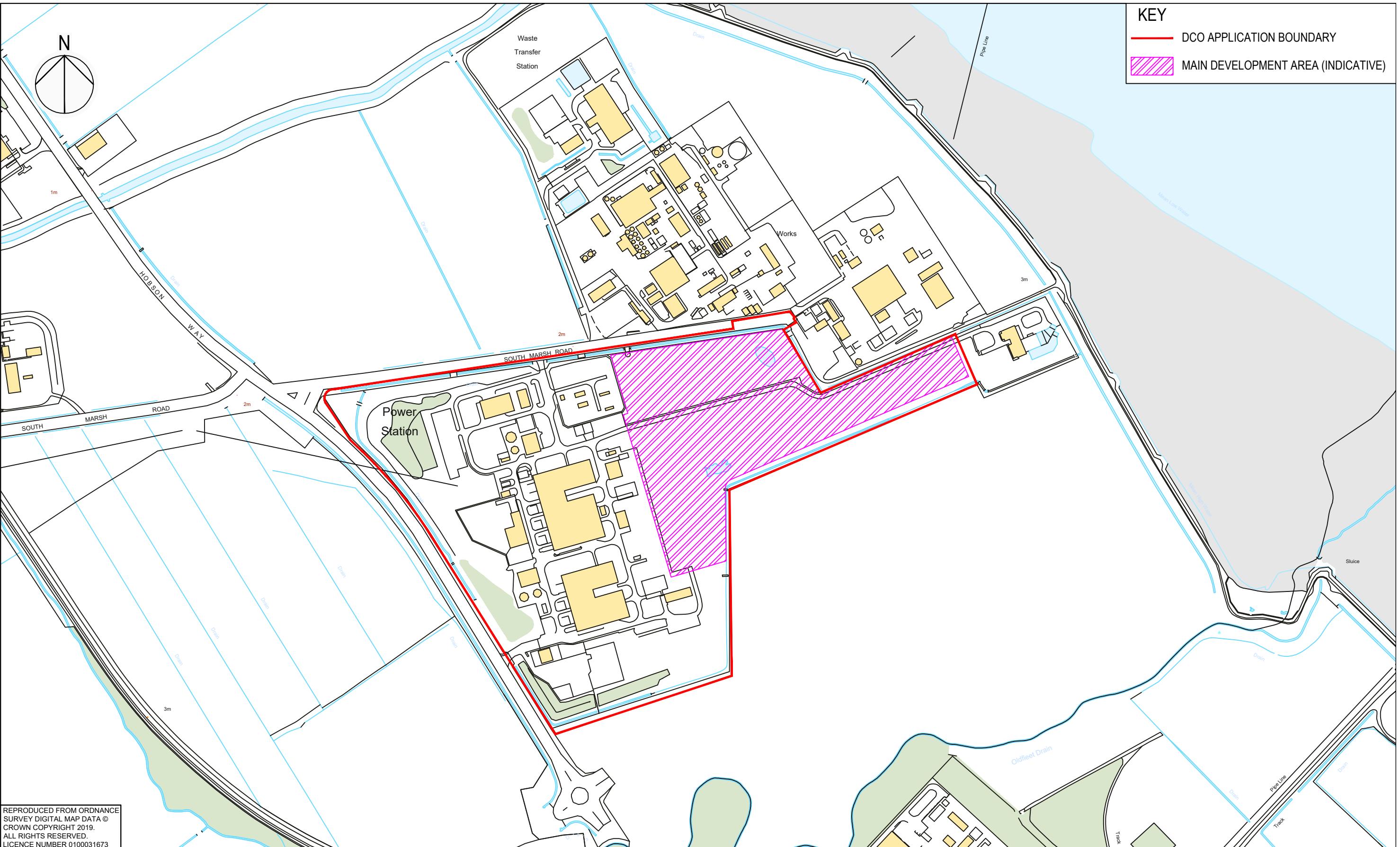


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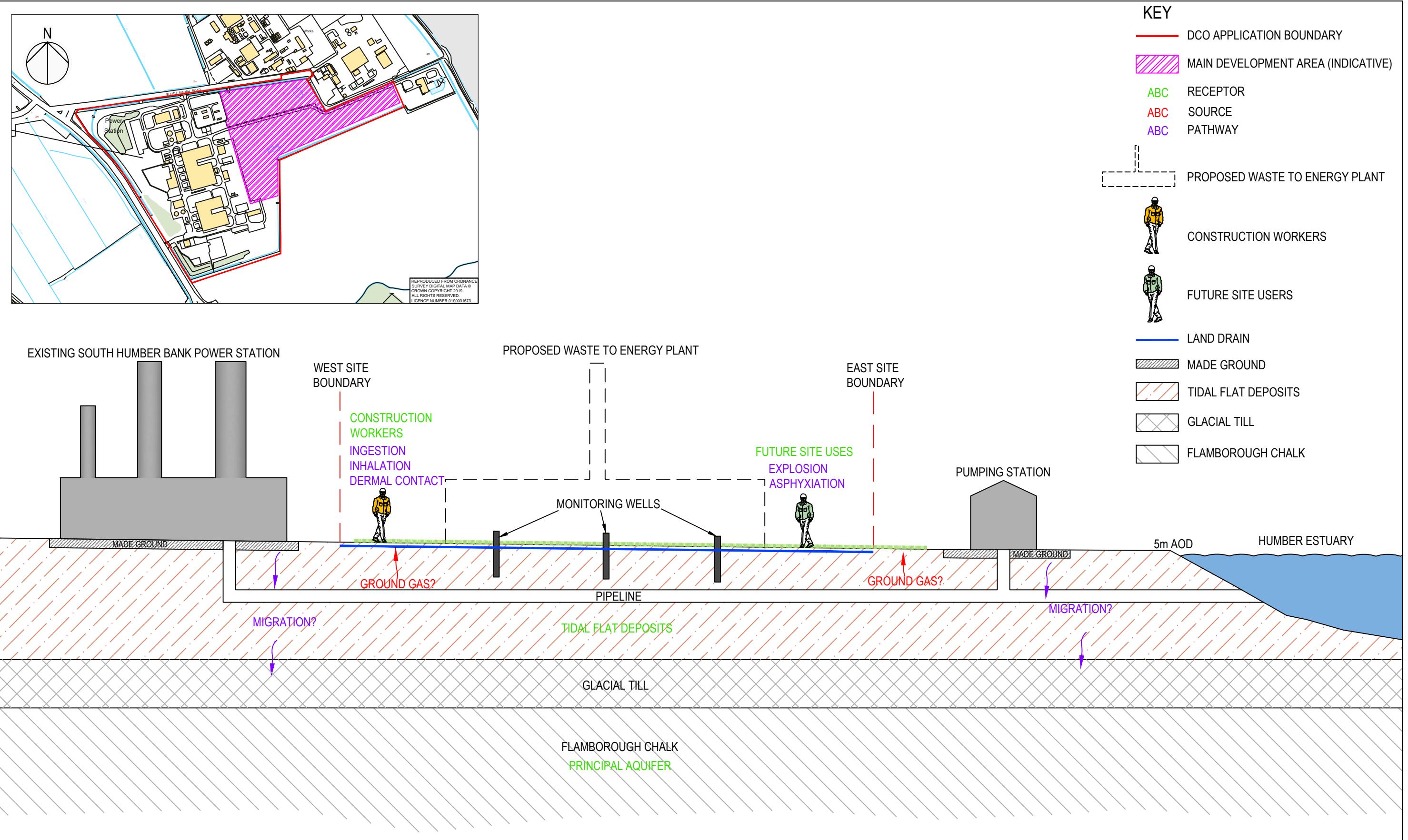
Drawing Title  SITE LOCATION	Purpose of issue  <b>PEI REPORT</b>		
	Drawn AAO	Checked SB	Approved DE
Date 07/18	Scale @ A4 1:50,000	Rev -	
Drawing Number  <b>60580855/DS/001</b>			

Plot Date : 04 October 2019 15:09:53

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Proposed Development  
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Boundary

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				Drawing Number <b>60580855/DS/004</b>
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