



Appendix 6.1 – Phase 1 Environmental Site Assessment

Aldbrough Hydrogen Pathfinder

PREPARED FOR



SSE Hornsea Ltd

DATE

June 2024

REFERENCE

0653313



CONTENTS

| | | |
|-----------|---|-----------|
| 1. | INTRODUCTION | 1 |
| 1.1 | OVERVIEW | 1 |
| 1.2 | BACKGROUND | 1 |
| 1.3 | OBJECTIVES | 1 |
| 1.4 | SCOPE OF WORKS | 1 |
| 2. | SITE DESCRIPTION | 2 |
| 2.1 | SITE LOCATION | 2 |
| 2.2 | SITE DESCRIPTION | 3 |
| 2.2.1 | Topography | 3 |
| 2.2.2 | Site layout | 3 |
| 2.2.3 | Current operations | 3 |
| 2.3 | SURROUNDING LAND USE | 4 |
| 3. | ENVIRONMENTAL SETTING | 5 |
| 3.1 | SOILS | 5 |
| 3.2 | GEOLOGY | 5 |
| 3.3 | HYDROGEOLOGY | 6 |
| 3.4 | HYDROLOGY AND SURFACE WATER | 7 |
| 3.5 | SENSITIVE LAND USES | 8 |
| 4. | SITE HISTORY | 8 |
| 4.1 | HISTORICAL MAPPING | 8 |
| 4.2 | OTHER HISTORICAL INFORMATION | 9 |
| 4.2.1 | Unexploded ordnance (UXO) | 10 |
| 5. | REGULATED ACTIVITIES | 10 |
| 6. | REVIEW OF PREVIOUS ENVIRONMENTAL REPORTS | 11 |
| 7. | INITIAL CONCEPTUAL SITE MODEL | 14 |
| 7.1 | OVERVIEW | 14 |
| 7.2 | POTENTIAL SOURCES | 14 |
| 7.3 | POTENTIAL RECEPTORS | 14 |
| 7.4 | POTENTIAL PATHWAYS | 15 |
| 8. | PRELIMINARY RISK ASSESSMENT | 16 |
| 8.1 | SENSITIVITY AND VULNERABILITY | 16 |
| 8.2 | POTENTIAL RISK | 19 |
| 9. | SUMMARY | 21 |

REFERENCES

22

LIST OF TABLES

| | |
|---|----|
| TABLE 1 – SUMMARY OF GEOLOGICAL SEQUENCE UNDERLYING THE SITE | 5 |
| TABLE 2 – SUMMARY OF ON-SITE HISTORY | 8 |
| TABLE 3 – SUMMARY OF OFF-SITE HISTORY | 9 |
| TABLE 4 – SUMMARY OF REGULATED ACTIVITIES | 10 |
| TABLE 5 – RECEPTOR SENSITIVITY | 16 |
| TABLE 6 – SENSITIVITY AND VULNERABILITY OF IDENTIFIED RECEPTORS | 16 |
| TABLE 7 – SUMMARY OF POTENTIAL RISK | 19 |

LIST OF FIGURES

| | |
|------------------------------|---|
| FIGURE 1 – SITE LOCATION MAP | 2 |
|------------------------------|---|

ACRONYMS AND ABBREVIATIONS

| Acronyms | Description |
|----------|---|
| aOD | above Ordnance Datum |
| AGS | Aldbrough Gas Storage |
| ALC | Agricultural Land Classification |
| bgl | Below ground level |
| BGS | British Geological Survey |
| BRE | Building Research Establishment |
| CSM | Conceptual Site Model |
| COMAH | Control of Major Accident Hazards |
| EA | Environment Agency |
| eDNA | Environmental DNA |
| ERYC | East Riding of Yorkshire Council |
| ESA | Environmental Site Assessment |
| ha | Hectare |
| HE | High explosive |
| iCSM | initial Conceptual Site Model |
| IPPC | Integrated Pollution Prevention and Control |
| km | kilometre |
| m | metre |
| MCZ | Marine Conservation Zone |

| Acronyms | Description |
|----------|---------------------------|
| OCGT | Open Cycle Gas Turbine |
| OS | Ordnance Survey |
| SPA | Special Protection Area |
| SPZ | Source protection zone |
| UKSO | UK Soil Observatory |
| UXO | Unexploded ordnance |
| WFD | Water Framework Directive |

GLOSSARY OF TERMS

| Acronyms | Description |
|----------------------------------|---|
| Agricultural Land Classification | A system of classification of agricultural resource value of soils in England devised by Natural England, from Grade 1 (best quality) to Grade 5 (poorest quality), and based on criteria including soil characteristics (depth, structure, texture, chemistry, stoniness) as well as climate and site aspects. |
| Aquifer | "Underground layers of water-bearing, permeable rock from which groundwater can be extracted" (Environment Agency). |
| Best and Most Versatile | "Agricultural land is land with an Agricultural land Classification of Grade 1 – Grade 3 (subgrade 3a)" (National Planning Policy Framework). |
| Conceptual Site Model | "A representation of the characteristics of a site which shows the possible relationships between contaminants, pathways and receptors" (Land Contamination Risk Management). |
| Made Ground | Land where the pre-existing ground surface is raised or replaced by artificial or man-made deposits. |
| Mineral Safeguarding Area | "An area designated by a Mineral Planning Authority which covers known deposits of minerals which are desired to be kept safeguarded from unnecessary sterilisation by non-mineral development" (Planning Practice Guidance). |
| Principle Aquifer | "Rocks that provide significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale. They typically have a high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage" (Environment Agency). |
| Secondary Aquifer | Rocks which "can provide modest amounts of water, but the nature of the rock or the aquifer's structure limits their use. They support water supplies at a local rather than strategic scale (such as for private supplies) and remain important for rivers, wetlands and lakes. They have a wide range of water permeability and storage" (Environment Agency). Secondary Aquifers may be further classified as 'A', 'B' or 'Undifferentiated' based on their permeability and ability to support local water supplies and/or base flow to rivers. |
| Source Protection Zone | Defined around large and potable groundwater abstractions sites with the purpose to "provide additional protection to safeguard drinking water quality through constraining the proximity of an activity what may impact upon a drinking water abstraction" (Environment Agency). |

1. INTRODUCTION

1.1 OVERVIEW

Environmental Resources Management Limited (ERM) has prepared a Phase 1 Environmental Site Assessment (ESA) for SSE Thermal's (SSE) 'Aldbrough Hydrogen Pathfinder' site, located adjacent to Garton Road (B1242) near Aldbrough (grid reference TA 260370), hereafter referred to as 'the Site'.

1.2 BACKGROUND

ERM understands that SSE proposes to partially redevelop its existing Aldbrough Gas Storage (AGS) Facility to produce, store and use 'green hydrogen' for the generation of low-carbon power by way of an Open Cycle Gas Turbine (OCGT).

The proposed redevelopment would comprise:

- repurposing of an existing salt cavern from its current use for storage of natural gas to storage of hydrogen;
- construction of OCGT infrastructure within the footprint of the existing AGS facility. This is anticipated to include compressors, electrolyzers, a transformer, gas flare, control room, demineralisation ponds, and a water treatment plant. An ammonia tank is also anticipated to be required; and
- refurbishment of an existing brackish water discharge pipe and associated infrastructure, running between the AGS facility and the North Sea, for discharge of brackish water from operational processes. The final scope of refurbishment is not yet known, but in a worst-case scenario local excavation may be required using a mobile excavator. The excavated materials would be replaced into the excavation as backfill materials. A maximum area of up to 750 m² is anticipated to be subject to disturbance as a result of this activity, including a temporary construction compound.

This Phase 1 ESA has been prepared to provide a preliminary assessment of the ground conditions and potential for contamination at the Site.

1.3 OBJECTIVES

The primary objective of the current scope of work is to undertake a Phase 1 ESA for the Site in line with the UK Government's *Land Contamination Risk Management* guidance for a 'Stage 1 Tier 1' risk assessment.

1.4 SCOPE OF WORKS

In order to meet the above objective, ERM undertook the following scope of works:

- review available environmental information relating to the Site and the immediate locality of the Site, including:
 - procurement of a Landmark Envirocheck® Report;
 - review of previous land use at the Site, to the extent this is possible via historical mapping, aerial photography etc.;
 - determination of the underlying geology and associated groundwater units at the Site, with regards to environmental sensitivity / vulnerability;

- determination of local surface water features / receptors at the Site, with regards to environmental sensitivity / vulnerability;
- review of historical permitting, relating to authorised processes, landfilling etc.; and
- review of information provided by SSE on current operations at the Site.
- undertake a preliminary risk assessment in relation to potential land contamination at the Site and the proposed redevelopment, considering such factors as the sensitivity of the identified local surface and groundwater features, the likely permeability of the underlying geology and the potential contaminants present from current / historical land use etc.; and
- prepare this Phase 1 ESA report.

No site walkover has been undertaken by ERM as part of the assessment due to the minimal change in land use. It was deemed in this instance that a walkover would not have provided additional info to that which could be obtained from the desk study.

2. SITE DESCRIPTION

2.1 SITE LOCATION

The Site is located approximately 2.5 km to the south-east of Aldbrough village and 21 km to the east of Beverley in the East Riding of Yorkshire. The eastern side of the Site extends to the North Sea coastline.

The Site location is shown on Figure 1, below.

FIGURE 1 – SITE LOCATION MAP



Source: Google Earth Imagery (2020)

2.2 SITE DESCRIPTION

2.2.1 TOPOGRAPHY

The Site covers a total area of approximately 39 ha. The Site is low-lying, flat land at an elevation of approximately 15 m above mean sea level. Sea cliffs are present at the far east of the Site, dropping down to the beach at sea level.

2.2.2 SITE LAYOUT

The Site comprises four main areas, as shown in Volume 2, Figure 2.3:

- the existing AGS facility (approximately 10 ha);
- the existing 'Aldbrough 1' underground salt cavern (approximately 1.5 ha), and access road (approximately 0.1 ha) adjacent to Garton Road;
- the route of the existing water discharge pipe between the AGS facility and the North Sea (approximately 22 ha, encompassing a 'corridor' approximately 40 m across to represent a reasonable worst-case scenario for the extent of potential ground disturbance as part of the pipeline refurbishment works); and
- a proposed laydown area for construction works (approximately 5.2 ha).

2.2.3 CURRENT OPERATIONS

Gas Storage Facility Area

The existing Aldbrough Gas Storage (AGS) facility comprises process trains, coolers, plant rooms, compressors, stores, vents, balancing lagoons and sumps, a substation and other ancillary infrastructure for the storage and distribution of natural gas. Nine underground caverns are associated with the AGS facility, of which one (known as 'Aldbrough 1') is located to the south-west (see below) and is connected to the gas storage area via an above-ground pipeline. The pipeline enters the south-western corner of the AGS facility and runs along the southern side of the area into the centre of the Site. The area is mainly covered in hardstanding towards the east and gravel towards the west. The access road runs around the western and northern sides of the facility. Car parking is present along the access road, as well as a designated car park in the far north-east of the AGS facility area. Small areas of landscaping (grass) are present around the perimeter, as well as a vegetated earth bund constructed as a visual screen around the facility.

Salt Cavern Area

The area of the existing 'Aldbrough 1' salt cavern comprises a fenced, gravel area on the eastern part and an asphalted car parking area on the western part. The salt cavern area is bound to the north by the main AGS facility access road. Small areas of landscaping (grass), trees and a vegetated earth bund are present around the perimeter. An above-ground pipeline runs from the centre of the gravel area, across Cess Dale Drain, used for transporting natural gas towards the main AGS facility. Cess Dale Drain runs north to south between the salt cavern and AGS facility areas.

Discharge Pipe Route

The discharge pipe area comprises arable farmland between the main AGS facility and the North Sea. The area envelops (but excludes) Ringbrough West (farm buildings). The discharge

pipeline area includes an indicative works area on farmland surrounding the pipeline where ground disturbance may be required to enable refurbishment works. The discharge pipe itself is understood to have been installed approximately 15 years ago, have a diameter of 500 – 600mm, is constructed of High Density Polyethylene (HDPE) and is buried at a depth of 1.2 m bgl.

At the far eastern end, the discharge pipeline area comprises exposed cliffs of Glacial Till (see Section 3.1) approximately 15 – 24 m in height, descending to a sandy beach. The existing pipe has reportedly become exposed at high tide level.

Proposed Laydown Area

The proposed laydown area is currently vacant land with scrubby, low-level vegetation (mostly grasses) and localised areas of hardstanding. It is understood to have previously been used as a construction compound during construction of the AGS facility and subsequently has an engineered (gravel) platform beneath the grassy surface. Two depressions, thought to be former attenuation ponds, are present at the north of the area and stockpiles of unknown materials are present in the west. The area is bound by trees on three sides and East Newton Drain to the north, flowing in a generally westerly direction.

Hazardous Substance Storage and Use

The following potentially hazardous substances are reportedly stored and used in the AGS facility and Salt Cavern areas:

- Lubricating oil: a total of 91,880 L is contained within the four on site compressors at the AGS facility, with much smaller volumes used for motor bearings and fans;
- Methanol: used at the wellhead in the salt cavern area for hydrate prevention. A maximum of 35,000 L is stored on site at any one time; and
- Glycol: used as a coolant in the hot water (26,400 L) and compressor (2,400 L) systems, diluted to 20% – 33% in water.

The Site reportedly operates in line with SSE's ISO14001 accredited Environmental Management System, which includes procedures for management, storage and handling of hazardous substances, including measures such as containment, spill response, labelling and staff training.

2.3 SURROUNDING LAND USE

The surrounding area is largely agricultural (arable) farmland. Based on available information, surrounding properties are understood to include:

- North: arable farmland, as well as the hamlet of East Newton (c. 700 m north of the Site boundary);
- East: The North Sea;
- South: arable farmland, as well as a second previously engineered vacant area (similar to the proposed laydown area). East Newton Drain (stream) flows in a generally westerly direction to the south of the AGS facility and discharge pipeline areas; and
- West: arable farmland, with Garton Road (B1242) adjacent west of the Aldbrough 1 salt cavern area. Isolated farm buildings and dwellings are present along Garton Road.

3. ENVIRONMENTAL SETTING

3.1 SOILS

According to UK Soil Observatory (UKSO) 'Soilscales' data¹, the majority of the Site is described as having '*slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils (Soilscape 18)*', with '*slightly acid, loamy and clayey soils with impeded drainage (Soilscape 8)*' at the far east of the Site.

Natural England's Agricultural Land Classification (ALC) map for Yorkshire and the Humber² indicates that the soils underlying the Site are classified as Grade 3 ('Good to Moderate').

3.2 GEOLOGY

According to British Geological Survey (BGS) online mapping³, as well as geological maps provided in the Envirocheck® Report, the Site is underlain by superficial deposits of Glacial Till, with localised alluvium (variable clay, silt, sand and gravel) associated with Cess Dale and East Newton Drains. Marine beach deposits (sand and gravel) are present at the coastline in the far east.

Bedrock underlying the Site is reported to comprise Rowe Chalk Formation.

Some Made Ground may be present overlying the Glacial Till in parts of the Site which have previously been developed. The nature of the Made Ground, if present, is unknown. Elsewhere, topsoil is anticipated to be present.

A stratigraphic cross section presented on the BGS 1:50,000 scale map (Sheet 73) and four available-to-view BGS borehole records within the Site boundary (TA23NE4 TA23NE6, TA23NE7 and TA23NE13) indicate the following geological sequence underlying the Site (see Table 1).

TABLE 1 – SUMMARY OF GEOLOGICAL SEQUENCE UNDERLYING THE SITE

| Stratum | Depth to Top (m bgl) | Depth to Base (m bgl) | Thickness (m) | General Description |
|---|----------------------|-----------------------|---------------|---|
| Glacial Till | 0.3m | 41.0 – 48.8 | 40.7 – 48.5 | Generally clayey glacial deposits with some sand and gravel layers. Overlain by ~0.3m of topsoil. |
| Chalk Group (including Rowe, Flamborough, Burnham, Weldon and Ferriby Chalks) | 40.7 – 48.8 | c.600 | >550 | White Chalk with occasional chert bands, highly weathered towards the top |
| Lias Group | c. 600 | c. 720 | c. 120 | Dark grey Mudstone and Siltstone |
| Penarth Group | c. 720 | c. 740 | c. 20 | Red-brown Mudstone |
| Mercia Mudstone | c. 740 | c. 920 | c. 180 | Red-brown Mudstone and Siltstone |

¹ UK Soil Observatory, *Soilscales*. Available online at: <https://mapapps2.bgs.ac.uk/ukso/home.html>

² Natural England (2010), *Agricultural Land Classification Yorkshire and The Humber (ALC003)*, 1:250,000 scale.

³ British Geological Survey, 1998, Map Sheet 73: Hornsea, Solid & Drift, 1:50,000 scale (<https://webapps.bgs.ac.uk/data/maps>) and British Geological Survey, *GeoIndex Onshore* (<https://mapapps2.bgs.ac.uk/geoindex/home>).

| Stratum | Depth to Top (m bgl) | Depth to Base (m bgl) | Thickness (m) | General Description |
|--------------------------------|----------------------|-----------------------|---------------|---|
| Sherwood Sandstone | c. 920 | c. 1,600 | c. 680 | Red Sandstone with Siltstone and Mudstone towards the base |
| Permian (Zechstein) Evaporites | c. 1,600 | >1,940 | > 340 | Evaporite sequence comprising mudstone, halite, polyhalite, anhydrite (gypsum) and dolomite. 'Main salt' (halite) logged from c.1,770m – c.1,920m bgl is inferred to correspond to the depth of the cavern. |

m bgl – metres below ground level

BGS online resources⁴ indicate that the coastal cliffs in the Aldbrough area are formed of Skipsea and Withernsea Glacial Till and are actively receding. An erosion rate of approximately 2 m was recorded in the last 50 years. Landslides, primarily by rotational slumping, are common due to the difference in erosion profiles of the different till materials. Numerous buildings in the area have been lost to coastal erosion since 1885.

According to the Coal Authority's online mapping⁵, the site is not located within a Coal Mining Reporting Area.

According to UK Radon mapping, the Site is in a low potential radon area, where less than 1% of homes are at or above the action level.

3.3 HYDROGEOLOGY

Environment Agency (EA) aquifer classifications for strata underlying the Site are as follows:

- Glacial Till – Secondary Undifferentiated Aquifer, defined as 'an aquifer where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value';
- Alluvium – Secondary A Aquifer, defined as 'permeable layers that can support local water supplies, and may form an important source of base flow to rivers'; and
- Rowe Chalk Formation – Principal Aquifer, defined as 'highly permeable aquifers with significant water storage and are able to support large abstractions'.

According to BGS borehole log TA23NE13, drilled at the Site in 2019 as a groundwater abstraction well, resting groundwater level beneath the Site was recorded at a depth of 13.5 m bgl. The well was installed from 46 m – 100 m bgl.

According to a Hydrogeological Impact Assessment report prepared by Atkins in 2019 (see Section 6), groundwater within the Chalk aquifer beneath the Site flows in an easterly direction towards the North Sea.

⁴ BGS (no date), *Landslides and coastal erosion at Aldbrough, East Riding of Yorkshire*. Available online at: <https://www.bgs.ac.uk/case-studies/landslides-and-coastal-erosion-at-aldbrough-east-riding-of-yorkshire-landslide-case-study/>.

⁵ The Coal Authority, *Interactive Map Viewer*. Available online at: <https://mapapps2.bgs.ac.uk/coalauthority/home.html>.

According to the Envirocheck® Report, there are two licenced groundwater abstractions within the Site boundary:

- SSE's groundwater abstraction at the AGS facility, abstraction licence ref. NE/026/033/011, issued March 2020 for 'Petrochemicals: general use' (inferred to correspond to BGS borehole ref. TA23NE13, see above); and
- A groundwater abstraction for 'general farming and domestic' use, abstraction licence ref. 2/26/33/001, dated December 1965 and registered to M.S. Meadley at Ringbrough Farm (inferred to correspond to either TA23NE4 or TA23NE6, see above). It is understood that this abstraction is no longer in use (see Section 6).

The Atkins 2019 Hydrogeological Impact Assessment report identified two current unlicensed, private groundwater abstractions, both used for agricultural purposes (pig farms), in the vicinity of the Site which were considered to have the potential to be affected by the AGS facility groundwater abstraction, as follows:

- Springfield Farm, c. 210 m west of the Site, abstraction rate <20 m³ per day, total well depth c. 65 m bgl, pump depth c. 40 m bgl; and
- Hilltop Farm, c. 1.3 km north of the Site, abstraction rate <20 m³ per day, total well depth c. 65 m bgl, pump depth unknown.

Information received from the EA on 30th June 2023 in response to a request for information on other (private) groundwater abstractions in the vicinity of the Site indicated that the AGS borehole is the only recorded abstraction within 1 km of the Site. ERM notes that this is contrary to the information obtained from the Envirocheck® Report and the 2019 Atkins Hydrogeological Impact Assessment (see above). East Riding of Yorkshire Council (ERYC) indicated via email on 30 June 2023 that they do not hold any information on private water supplies within 1 km of the Site.

The Site is not located within a groundwater Source Protection Zone (SPZ) nor a Drinking Water Safeguard Zone with respect to groundwater, and none are located within 1 km of the Site. Combined groundwater vulnerability is classified as 'medium' across the majority of the Site, with a small area classified as 'high' vulnerability at the far eastern side.

The regional Water Framework Directive (WFD) groundwater unit in the vicinity of the Site (Hull and East Riding Chalk operational catchment) is classified by the EA as having an overall 'poor' quality (2019 classifications), reportedly related to poor nutrient / agriculture / rural land management in the area. Given the proximity to the North Sea, saline intrusion is also possible.

3.4 HYDROLOGY AND SURFACE WATER

A series of surface water drains, part of the Cess Dale and East Newton Drain networks, crosses the Site and surrounding fields. Cess Dale and East Newton Drains meet adjacent to the south-eastern corner of the salt cavern part of the Site. From this point, the watercourse is known as Bail Drain and flows in a generally south-westerly direction towards Humbleton Beck.

The Site is not located within a Drinking Water Safeguard Zone with respect to surface water.

According to the Envirocheck® Report, there are two licenced surface water abstractions on site (both with licence reference 2/26/33/031), registered to Jacobs Engineering UK Limited for abstraction of water from Cess Dale Drain for 'dust suppression' and 'conveying materials'. The

permits were issued in 2004 and are inferred to relate to earthworks during construction of the AGS facility, which was complete in 2012.

The Site is located within the WFD Humbleton Beck Water Body, which is classified by the EA as having 'moderate' ecological quality (2019 classifications).

According to the EA's flood maps for planning, the Site is located with a Flood Zone 1, which is defined as having a low (<0.1%) probability of flooding from rivers or the sea in any given year. The Envirocheck® Report indicates that the majority of the Site is located in an area at 'low' risk of surface water flooding (i.e. flash flooding from extreme rainfall events), with localised areas close to the surface watercourses and on roadways classified as 'high' risk (flooding possible in a 30-year rainfall event). The Envirocheck® Report indicates that the Site has limited potential for groundwater flooding (i.e. emergence of groundwater at the surface).

3.5 SENSITIVE LAND USES

The nearest residential property to the Site is a dwelling at Ringbrough West, located within the eastern (discharge pipeline area) part of the Site. Additional isolated dwellings are located approximately 210 m west of the Site on the western side of Garton Road. The nearest settlements are the hamlets of East Newton (approximately 700 m north), Garton (approximately 1 km south) and Grimston (approximately 1.7 km south). Aldborough village is approximately 2.5 km north-west of the Site.

Environmentally sensitive sites within 1 km of the Site include:

- Greater Wash Special Protection Area (SPA), which includes the beach at the far east of the Site (as far as the mean high tide level);
- Holderness Inshore Marine Conservation Zone (MCZ), which includes the beach at the far east of the Site (as far as the mean high tide level); and
- Bail Wood ancient woodland and priority habitat, located approximately 110 m to the west of the Site, beyond Garton Road.

4. SITE HISTORY

4.1 HISTORICAL MAPPING

Historical Ordnance Survey (OS) maps obtained as part of the Envirocheck® Report (1855 – 2023), as well as publicly available aerial imagery (Google Earth, 2003 – 2022) indicate the following on-site (Table 2) and offsite history (Table 3, pertinent features within approximately 500 m of the Site only):

TABLE 2 – SUMMARY OF ON-SITE HISTORY

| Map / Image Date | Description |
|------------------|--|
| 1855 - 1978 | The Site is undeveloped, agricultural land. Ringbrough Farm is present at the far east of the Site, including three circular structures of unknown use (see Section 6), and a 'pump' labelled from 1975 (inferred to relate to the licensed groundwater abstraction, see Section 3.4). |
| 1995 - 2003 | Evidence of development of the salt cavern area of the Site, including earthworks, is visible on the 1995 map, although no buildings are present. The remainder of the Site remains essentially unchanged. |

| Map / Image Date | Description |
|------------------|--|
| 2007 - 2023 | <p>The AGS facility has been constructed on the Site, generally consistent with its current layout. An above-ground pipeline is visible connecting the salt cavern area with the gas storage area.</p> <p>The proposed laydown area appears to be bare soil, with evidence of a pond (inferred to be an attenuation pond) present in the north of the area.</p> <p>Many of the Ringbrough Farm buildings have been lost to coastal erosion during this period (mostly between 2007 and 2012).</p> <p>A concrete structure at the location of the water discharge pipe outfall is visible on the beach in aerial photographs from 2007 onwards.</p> |

TABLE 3 – SUMMARY OF OFF-SITE HISTORY

| Map / Image Date | Description |
|------------------|---|
| 1857 – 1999 | <p>The wider area also comprises undeveloped, agricultural land.</p> <p>A spring is shown to the north of Ringbrough Farm, close to the north-eastern corner of the Site.</p> <p>The mapped location of the coastline recedes westwards by nearly 200 m during this period.</p> |
| 2003 - 2023 | <p>Ringbrough West (farm) has been constructed within the eastern (discharge pipeline area) part of the Site by 2003.</p> <p>The coastline recedes to its current position during this period.</p> <p>The remainder of the surrounding area remains essentially unchanged.</p> |

4.2 OTHER HISTORICAL INFORMATION

The existing salt cavern, known as Aldbrough 1, was created by solution mining in 2005 and is currently used for storage of natural gas. SSE's AGS facility commenced operation in 2011. A further eight similar caverns are understood to be present beneath the wider site and surrounding area (which are not proposed to be altered as part of the proposed redevelopment). The cavern is reported to extend from a depth of 1,782 m bgl to 1,860 m bgl (based on 2018 sonar surveys by DEEP.KBB). No integrity issues were identified by Atkins in the Feasibility Study.

According to Historic England research records⁶, Ringbrough Farm was reportedly used as an WWII artillery battery from 1941 to 1943, including barracks, pill boxes, observation posts, a guard room, three engine houses, a workshop and ammunition stores, as well as the original farm buildings.

⁶Heritage Gateway (2012), *Historic England Research Records – Ringbrough Battery*. Available online at: https://www.heritagegateway.org.uk/Gateway/Results_Single.aspx?uid=915262&resourceID=19191

4.2.1 UNEXPLODED ORDNANCE (UXO)

Online unexploded ordnance (UXO) risk mapping by Zetica⁷ classifies the risk of UXO at the Site as 'low'. However, a decoy site⁸ is identified approximately 220 m to the north of the Site.

A Detailed Unexploded Ordnance Risk Assessment was undertaken, which covers the current study site as well as areas to the north, south and east (offshore). It records the following:

- according to Home Office statistics, the Rural District of Holderness sustained an 'overall low density of bombing with an average of 15.2 items of ordnance dropped per 1,000 acres';
- the nearest significant bombing target in the area was Hull docks, approximately 11 km south of the Site, but a bombing decoy just north of the Site was also present;
- a written bomb census report from January 1942 indicated that the decoy site close to the northern Site boundary was responsible for the fall of several cluster bombs and high explosive (HE) bombs, some of which may have fallen within the current site boundary;
- written historical records identified at least two air raids in 1943 which may have impacted the Site, including an incendiary cluster bomb and a 500 kg HE bomb landing on or close to the north-western corner of the Site;
- an allied heavy anti-aircraft battery defence station was located at Ringbrough Farm (on site) and an Auxiliary Unit operated from Bail Wood, approximately 130 m west of the Site;
- based on the local geology, potential bomb penetration depth is anticipated to be up to 12 m bgl; and
- an overall 'medium' risk from UXO was assigned to the Site and it was recommended that all ground disturbance works should be subject to mitigation measures such as a UXO Risk Management Plan, awareness briefings, magnetometer surveys and UXO specialist on-Site support.

5. REGULATED ACTIVITIES

Table 4, below, summarises regulated activities identified by the Envirocheck[®] Report within 500 m of the Site which are considered to have the potential to impact upon environmental conditions at the Site.

TABLE 4 – SUMMARY OF REGULATED ACTIVITIES

| Activity | Location Relative to Site | Description |
|--------------------|---------------------------|---|
| Discharge Consents | On site | Consents (ref. EPRHP3336SL) granted to SSE Hornsea Ltd in 2015 for discharge of site drainage, process water and treated effluent to Cess Dale Drain, relating to 'extraction of crude petroleum and natural gas' and 'substation / electricity / gas /air conditioning supply' operations. |

⁷Zetica (2024), *Risk maps*. Available online at: <https://zeticauxo.com/downloads-and-resources/risk-maps/>

⁸ Decoy sites were developed during WWII to create false bombing targets that were realistic enough to divert enemy aircraft away from the authentic ones.

| Activity | Location Relative to Site | Description |
|--|--|---|
| Integrated Pollution Prevention and Control (IPPC) | On site | Permit (ref. HP3336SL/PP3236AE) originally granted in 2007 to SSE Hornsea Ltd for 'gasification, liquification and refining; refining gas greater or equal to 1000Te/year'. |
| Control of Major Accident Hazards (COMAH) | On site | Upper Tier COMAH entry relating to SSE's AGS facility. |
| Planning Hazardous Substance Consents | Listed as 40m west of the site, but inferred to be on site | Consent granted to SSE Hornsea Limited in 2005 for storage / use of 'liquified extremely flammable gas and natural gas' at the AGS facility. |

No active Contaminated Land Register entries, Prosecutions relating to Controlled Waters, Enforcement and Prohibition Notices, Integrated Pollution Controls, Local Authority Pollution Prevention and Controls, Local Authority Integrated Pollution Prevention and Controls, Pollution Incidents to Controlled Waters, Prosecutions relating to Authorised Processes, Registered Radioactive Substances, Water Industry Act Referrals, Substantiated Pollution Incident Register entries, BGS Recorded Landfills, Historical Landfill Sites, Integrated Pollution Control Registered Waste Sites, Local Authority Recorded Landfill Sites, Registered Landfill Sites, Licensed Waste Management Facilities, Registered Waste Transfer, Treatment or Disposal Sites, Explosives Sites, Fuel Station entries or Contemporary Trade Directory entries are recorded by the Envirocheck® Report within 500 m of the Site.

6. REVIEW OF PREVIOUS ENVIRONMENTAL REPORTS

Atkins, Aldbrough Hydrogen Pathfinder – Feasibility Study Report, dated October 2022

A feasibility study undertaken by Atkins in 2022 noted the following in relation to ground conditions at the site:

- potential alluvium at the site may present a geotechnical risk in relation to compressibility, as well as having the potential to generate ground gas;
- limited ground investigation data was available for the site and a site-specific ground investigation was recommended to determine geotechnical parameters for foundation design;
- a piling risk assessment was recommended prior to construction to minimise potential impact on the underlying chalk aquifer; and
- groundwater monitoring was recommended to understand seasonal fluctuation and inform foundation design.

It is not known if any of these recommendations have been completed.

In addition, the report noted the former presence of three 'unspecified tanks' adjacent to Ringbrough Farm. No tanks were labelled on historical maps obtained by ERM as part of the current assessment. Three circular structures were identified in this location (see Section 4.1), but their depiction on historical mapping is not considered consistent with storage tanks. Various structures and buildings were reportedly present at Ringbrough Farm related to its use as an artillery battery during WWII. It is possible that fuel storage tanks were present (e.g. related to the engine houses) but the actual use of the circular structures is unknown. Furthermore, based on historical mapping, the circular structures were lost to coastal erosion sometime between 1976 and 1995.

Atkins, Aldbrough 4z Borehole Support – Hydrogeological Impact Assessment, dated October 2019

Atkins undertook a hydrogeological risk assessment in 2019 to support the abstraction licence application for the on-site groundwater abstraction, known as 'ALD1'.

The following pertinent information was included within the report:

- the borehole was drilled in July / August 2019 to a depth of 100m bgl. Glacial Till was encountered to a depth of 41 m bgl, underlain by Chalk bedrock. The Chalk was reported to be highly fractured to approximately 65 m bgl, below which it was described as 'competent';
- test pumping (a step test and a constant rate test) was carried out on the newly-drilled borehole. Groundwater level monitoring was carried out at two observation wells, located at Springfield Farm (actively used, c. 210 m west of the current study site and 855 m west of ALD1) and Ringbrough Farm (reported to be disused, located on the far eastern part of the current study site and 1,070 m east of ALD1). In addition, samples were collected from the observation wells before and after the test pumping for water quality monitoring purposes;
- resting groundwater level in the abstraction borehole (prior to test pumping) was recorded at an elevation of 0.85 – 1.05 m above Ordnance Datum (aOD). A tidal oscillation of approximately 0.1 m was identified. In the observation borehole at Ringbrough Farm, located immediately adjacent to the North Sea coastline, significant tidal oscillation was recorded (approximately 1.2 m);
- effects of the constant rate test were recorded in both observations wells, up to 1.5 m at Springfield Farm and up to 2.1 m at Ringbrough farm (when corrected for tidal effects). Atkins reported that this indicated that transmissivity was greater inland from the ALD1 borehole than towards the coast;
- electrical conductivity monitoring reportedly showed no significant change in ALD1 or the observation wells during the pump tests, suggesting that saline water was not drawn into the wells as a result of the pumping. Nevertheless, the report identifies the potential upwelling of saline water into the Chalk aquifer as a potential long-term impact of the proposed abstraction and operational monitoring of electrical conductivity was proposed to mitigate this risk. Elevated concentrations of iron and manganese were measured in the groundwater, reportedly consistent with the Chalk aquifer in the wider area. No adverse impacts on water quality were reported in the observation wells (or ALD1) as a result of the test pumping; and

- the CSM presented in the report indicates that there is no hydraulic connectivity between surface water features and groundwater in the vicinity of the site. ERM notes that this is assumed to mean groundwater within the Chalk bedrock aquifer; shallow groundwater may also be present in Made Ground and / or superficial deposits (Alluvium).

Norwest Holst Soil Engineering Limited, Report on a Ground Investigation at Aldbrough Gas Storage Facility, dated September 2003

Norwest Holst undertook a ground investigation at the site in July 2003 to assess ground conditions in the location of the (at the time) proposed AGS facility. The investigation comprised:

- 16 cable percussive boreholes to depths of between 5.0 m and 10.5 m bgl, including three installed as groundwater monitoring wells;
- 29 mechanically excavated trial pits to depths of between 2.3 m and 4.0 m bgl;
- Three trial trenches, approximately 12 m to 17 m in length to depths of between 3.1 m and 4.0 m bgl; and
- Collection of soil samples for geotechnical testing, including moisture content, particle size distribution, dry density, California Bearing Ratio, consolidation, triaxial compression and BRE sulphate testing.

All investigation locations were within, or on the boundary of, the footprint of the AGS facility area subject to the current study.

The key findings of the investigation were reported as follows:

- No Made Ground was present in any of the investigation locations;
- All investigation locations encountered a sequence of superficial strata comprising slightly sandy, slightly gravelly Clay, Sand and Gravel and clayey gravelly Sand;
- All investigation locations terminated within the superficial deposits. No bedrock was encountered; and
- Groundwater was encountered in nine borehole and 10 trial pit locations, at depths of between 2.0 m and 8.6 m bgl.

Mott MacDonald, Aldbrough Gas Storage Facility Ground Investigation Interpretative Report, dated November 2003

Mott MacDonald prepared an interpretative report based on the Norwest Holst investigation (above) in November 2003. The report contained the following additional information:

- a summary of a 1992 ground investigation was provided, which comprised five trial pits within the AGS facility area boundary to a maximum depth of 2.5 m bgl. All of the trial pits reportedly encountered stuff to very stiff, sandy gravelly Clay, consistent with Glacial Till. Geotechnical testing on soil samples from the trial pits indicated that the material tested comprised intermediate to high plasticity clays;
- groundwater monitoring of three wells undertaken by Norwest Holst following the ground investigation in July 2003 reported resting groundwater levels between 0.83 m and 3.2 m bgl, being shallowest in the well located in the north-western part of the site. Resting groundwater levels within the superficial deposits in two of the wells were reported to be generally consistent with the water level in Cess Dale and East Newton Drains. The

shallowest groundwater was concluded to be 'perched', as a result of local variations in permeability;

- alluvium was encountered in approximately one third of the investigation locations, typically as a clayey sand with occasional gravel and cobbles, with a maximum recorded thickness of 2.1 m; and
- the report recommended that pad or strip foundations would likely be suitable for lightly loaded structures, based on the geotechnical testing completed. However, for heavier structures, and in locations where less competent Alluvium was encountered, it was recommended that shallow foundations were not used.

7. INITIAL CONCEPTUAL SITE MODEL

7.1 OVERVIEW

The risk assessment process for environmental contaminants is based on the potential for complete source-pathway-receptor linkages, where:

- **Source:** a hazardous substance that has the potential to cause adverse impacts;
- **Pathway:** a route by which a hazardous substance may come into contact with a receptor; and
- **Receptor:** a target that may be affected by contamination.

For a risk to be present, there must be a complete, viable contaminant linkage; i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway.

The following sections detail the initial Conceptual Site Model (iCSM). Identified potential sources, receptors and pathways are summarised in the following sections.

7.2 POTENTIAL SOURCES

The following potential sources of contamination have been identified:

On-site:

- Made Ground placed to create building platforms during previous site development, as well as possible infilling of former drains / ponds;
- potential sources of contamination associated with the current AGS facility, including the storage and use of lubricating oil, methanol and glycol. Potential future sources associated with the proposed redevelopment are understood to be similar to those already present at the existing AGS facility;
- long-term pesticide / herbicide use on arable farmland; and
- potential historical sources of contamination associated with Ringbrough Farm, including its use as a farm (e.g. storage and use of pesticides, hydrocarbons) and as an artillery battery (e.g. metals, hydrocarbons, asbestos).

Offsite:

- Long-term pesticide / herbicide use on arable farmland.

7.3 POTENTIAL RECEPTORS

The following potential receptors have been identified:

Human Health:

- Current and future site users; and
- Current and future users of neighbouring properties, including residential properties and farms.

Controlled Waters:

- Surface waters:
 - Cess Dale and East Newton Drains; and
 - The North Sea.
- Groundwater:
 - Superficial Aquifer – Glacial Till (Secondary Undifferentiated Aquifer) and Alluvium (Secondary A Aquifer); and
 - Bedrock Aquifer – Rowe Chalk Formation (Principal Aquifer), including abstractions for agricultural and industrial use.

Ecological:

- Flora and Fauna, including in the Greater Wash SPA, Holderness Inshore MCZ and Bail Wood ancient woodland / priority habitat.

Buildings & Infrastructure:

- Below-ground structures, including concrete foundations and plastic water supply pipes.

7.4 POTENTIAL PATHWAYS

The following potential pathways by which the identified potential receptors may be impacted by the identified potential sources have been identified:

Human Health:

- inhalation, ingestion or direct contact with contaminants in soil, including asbestos, in unsurfaced areas (including soil-derived dust);
- inhalation of vapours derived from volatile contaminants in soil and / or shallow groundwater;
- inhalation of ground gases derived from Made Ground / alluvium; and
- acute risks to maintenance and construction workers by accidental ingestion, inhalation or direct contact with contaminants in soil and / or shallow groundwater during potential works involving ground disturbance.

Controlled Waters:

- direct surface run-off into surface waters (in the immediate vicinity of surface watercourses);
- erosion and / or collapse of impacted soil within coastal cliffs into the North Sea;
- leaching of contaminants from shallow soil into shallow groundwater (if present);
- vertical migration of contaminants within shallow groundwater to deeper groundwater (i.e. bedrock aquifer), including via preferential pathways such as piles (if present);
- lateral migration of contaminants within shallow groundwater to surface water; and

- preferential migration of contaminants along the routes of underground services (including granular backfill materials), including the brackish water discharge pipe, to surface water.

Ecological:

- inhalation, ingestion or direct contact with contaminants in soil in unsurfaced areas (including soil-derived dust);
- uptake of contaminants in shallow groundwater (if present) by root systems (flora); and
- contact with contaminants entering surface waters.

Buildings & Infrastructure:

- migration of ground gases derived from Made Ground / alluvium and accumulation in confined spaces (e.g. basements, sumps, service trenches); and
- direct contact of subsurface structures (e.g. foundations, gas membranes, water supply pipes) with contaminants in soil and / or shallow groundwater (if present).

8. PRELIMINARY RISK ASSESSMENT

8.1 SENSITIVITY AND VULNERABILITY

For the purpose of this assessment, sensitivity is defined as the potential significance of impacts (should any exist) (see Table 5) and vulnerability is defined as the likelihood for impacts (should any exist) to reach a sensitive receptor.

TABLE 5 – RECEPTOR SENSITIVITY

| Sensitivity | Receptor |
|--------------------|---|
| High | Human health: onsite residential developments, onsite construction workers Controlled waters (groundwater): Source Protection Zone or Highly productive aquifer Agriculture: Presence of best and most versatile land (Grades 1, 2 or 3a) |
| Medium | Human health: onsite commercial developments, offsite residential developments Controlled waters (groundwater): Moderately productive aquifer Agriculture: Presence of land of moderate quality (Grade 3b) |
| Low | Human health: transient or limited access, off site commercial development Controlled waters (groundwater) Low productivity aquifer or rocks essentially with no groundwater Agriculture: Presence of land of poor quality (Grade 4) |

Table 6, below, summarises the sensitivity and vulnerability of the identified receptors to potential impacts associated with the identified potential sources of contamination.

TABLE 6 – SENSITIVITY AND VULNERABILITY OF IDENTIFIED RECEPTORS

| Identified Receptor | Sensitivity | Vulnerability | Explanation |
|-------------------------------|--------------------|----------------------|---|
| Human Health | | | |
| Current and future site users | High | Moderate | Some parts of the site are currently unsurfaced and there is therefore the potential for direct exposure of site users to contaminated soil (if present). |
| Current and future users of | High | Very Low | |

| Identified Receptor | Sensitivity | Vulnerability | Explanation |
|-------------------------|-------------|---------------|---|
| neighbouring properties | | | <p>Although there is the potential for generation of dust, the relatively significant distance between the locations of identified potential contamination at the site (i.e. the existing AGS facility and Ringbrough Farm) and the nearest residential properties makes exposure of offsite human health receptors to significant dust levels unlikely.</p> <p>Laterally continuous (i.e. not perched) groundwater is anticipated to be at least approximately 3 m bgl, so the potential for exposure to groundwater-derived contamination (e.g. by vapour partitioning) is considered to be low.</p> <p>The nature of Made Ground at the site is unknown. However, it is inferred to have been placed after 2003 for construction of the AGS facility and is therefore anticipated to be controlled, engineered fill.</p> <p>The extent of Alluvium is relatively limited. The potential for significant generation of ground gases is therefore considered unlikely.</p> |

Controlled Waters

| | | | |
|--|------|-----------------|---|
| Surface Water – Cess Dale and East Newton Drains | High | Moderate / High | <p>Surface water drains run through the site and adjacent to the site boundary in some places. Given the close proximity, direct runoff (e.g. if a spill occurs) is considered possible. Shallow / perched groundwater may be present with the Made Ground and Alluvium, where present. Although this is unlikely to be extensively laterally continuous, it is thought to be in connectivity with the surface water drains in some locations. Lateral migration within shallow / perched groundwater to the drains is therefore considered possible. Migration via preferential pathways, e.g. drainage network / backfilled service trenches is also possible. The site holds discharge consents to discharge water into Cess Dale Drain, indicating that a potential preferential pathway along drainage pipes is likely to exist.</p> |
| Surface Water – North Sea | High | Moderate | <p>Ringbrough Farm, at the far eastern end of the site, is immediately adjacent to the North Sea coastline. Impacted soil (if present) in this area may directly enter the North Sea via coastal erosion processes.</p> <p>Groundwater is likely to be in lateral continuity with the sea at the coast, creating a potential pathway for migration of contaminants (if present). Furthermore, the existing water discharge pipeline route, which is exposed at the North Sea shoreline, may act as a preferential pathway for migration of contaminants from the site towards the North Sea.</p> |

| Identified Receptor | Sensitivity | Vulnerability | Explanation |
|---|----------------|---------------|---|
| Groundwater (superficial) – Secondary A and Secondary Undifferentiated Aquifers | Low / Moderate | Moderate | The geological setting of the site primarily consists of relatively low permeability superficial deposits (Glacial Till), with localised Alluvium, underlain by Rowe Chalk Formation bedrock. The Glacial Till is classified as a Secondary Undifferentiated Aquifer and the Alluvium as a Secondary A Aquifer. Lateral continuity of groundwater within these units may be limited (e.g. confined to sandy lenses / layers in the Glacial Till and sands / gravels in the Alluvium) and no identified licensed groundwater abstractions are present in these strata. Depth to groundwater in the superficial deposits is unknown. |
| Groundwater (bedrock) – Principal Aquifer | High | Low | Licensed abstractions have been identified on site from the Chalk bedrock (Principal Aquifer), including for domestic use at Ringbrough Farm (although this abstraction is unlikely to still be in use), and within 1 km of the site. However, the Glacial Till is > 40 m in thickness in the vicinity of the site and is therefore anticipated to afford significant protection to the underlying Principal Chalk Aquifer from potential vertical migration of contaminants. The potential for piles to act as preferential pathways to the bedrock aquifer cannot be ruled out – no foundation design information was available for the current site structures. The site is not located in an SPZ. |

Ecological

| | | | |
|-----------------|------|----------|---|
| Flora and fauna | High | Moderate | <p>The North Sea coastline, up to mean high tide level, is part of the Greater Wash SPA and Holderness Inshore MCZ. Fauna at the coastline may be directly exposed to contaminated soil in the cliffs (if present), as well as indirectly exposed via impacted groundwater migrating from beneath the site. Inland, various parts of the site are used as arable farmland, landscaping, trees and rough, vegetated areas. Direct contact (by fauna) or uptake (by flora) of contaminants from soil / shallow groundwater (if present) is possible in these areas. In addition, flora and fauna may use surface waters which run through, and close to, the site.</p> <p>No evidence of stressed vegetation or visibly impacted surface water quality has been reported at the site.</p> <p>Due to the relatively significant distance from the Site (c. 290 m), Bail Wood ancient woodland / priority habitat is considered unlikely to be impacted by potential contamination at the site.</p> |
|-----------------|------|----------|---|

Buildings & Infrastructure

| | | | |
|-------------------------|-----|-----|--|
| Below-ground structures | Low | Low | Limited information is available on the design and layout of the buildings currently present at the site. However, given that the only occupied buildings (i.e. the AGS facility) were |
|-------------------------|-----|-----|--|

| Identified Receptor | Sensitivity | Vulnerability | Explanation |
|---------------------|-------------|---------------|---|
| | | | constructed in the 2000s it is assumed that appropriate consideration was given to potential ground contamination and mitigation measures, if required. |

8.2 POTENTIAL RISK

Table 7 below summarises ERM's assessment of potential risk to the identified receptors from potential sources of contamination identified at the site, based on the information reviewed and the assessment of sensitivity and vulnerability of the identified receptors above.

TABLE 7 – SUMMARY OF POTENTIAL RISK

| Identified Receptor | Potential Risk | Explanation |
|---|----------------|---|
| Human Health | | |
| Current and future site users | Low | Limited potential sources of contamination have been identified at the site, largely confined to the current AGS facility and Ringbrough Farm. Procedures for management, storage and handling of hazardous substances at the AGS facility are in place and the potential for widespread or gross contamination to be present is considered to be low. The potential for ground gas is also considered to be low. Therefore, although some areas of the site are unsurfaced, the potential risk to site user is considered to be low. Given the distance between identified potential sources of contamination at the site and offsite residential properties, the potential risk to neighbouring occupants is considered to be very low. Furthermore, it is assumed that any planned ground disturbance works would be undertaken in line with current best practice and mitigation measures put in place as necessary to reduce the likelihood of exposure to contaminated soils. |
| Current and future users of neighbouring properties | Very Low | |
| Controlled Waters | | |
| Surface Water – Cess Dale and East Newton Drains | Low / Moderate | Limited potential sources of contamination have been identified at the site, largely confined to the current AGS facility and Ringbrough Farm. Procedures for management, storage and handling of hazardous substances at the AGS facility are in place and the potential for widespread or gross contamination to be present is considered to be low. However, surface water drains run through, and close to the perimeter of, the site and the potential for direct runoff (in the case of an accidental release / spill) to surface waters cannot be discounted. Furthermore, contaminants leached into shallow groundwater may migrate laterally into surface water, via Made Ground and / or Alluvium where present, or via preferential pathways (drains). The overall level of risk to surface waters from potential pollutant linkages at the site is therefore considered to be low to moderate. |
| Surface Water – North Sea | Low | If residual contamination is present at Ringbrough Farm, there is the potential for direct release of impacted soil into the sea via coastal erosion. However, most of the historical farm and artillery barracks buildings (and the potentially contaminated ground beneath them) have already been lost to coastal erosion, including the potential ‘unspecified tanks’ identified by Atkins in 2022. Therefore, although potential pollutant linkages may exist, the potential for significant contamination to be remain in this location at the current time, and |

| Identified Receptor | Potential Risk | Explanation |
|---|----------------|---|
| | | therefore the risk to the North Sea, is considered to be low. Furthermore, given the significant distance from other identified sources of contamination (i.e. the AGS facility) to the North Sea, the potential risk from migration via groundwater or preferential pathways (brackish water discharge pipe route) is considered to be low. |
| Groundwater (superficial) – Secondary A and Secondary Undifferentiated Aquifers | Low | Limited potential sources of contamination have been identified at the site, largely confined to the current AGS facility and Ringbrough Farm. Procedures for management, storage and handling of hazardous substances at the AGS facility are in place and the potential for widespread or gross contamination to be present is considered to be low. Although the Alluvium is classified as a Secondary A Aquifer, no identified abstractions from the superficial aquifers have been identified within 1 km of the site and the site is not located in an SPZ. No environmentally sensitive receptors have been identified which depend on superficial groundwater in the vicinity of the site (e.g. groundwater-fed wetlands). The potential risk to superficial aquifers from contamination at the site is therefore considered to be low. |
| Groundwater (bedrock) – Principal Aquifer | Low | The Chalk bedrock is classified as a Principal Aquifer and two abstractions from this unit have been identified on site – one for process water at the AGS facility and the other for farming and domestic use at Ringbrough Farm. Given that the farm is no longer occupied and many of the buildings have been lost to coastal erosion, the abstraction is no longer likely to be in use. One further abstraction for agricultural purposes has been identified approximately 300 m west of the site. The site is not in an SPZ. Furthermore, the presence of over 40 m of low permeability Glacial Till overlying the Chalk aquifer will limit vertical migration of contaminants. The nature of the foundations of buildings and structure on site is not known. However, assuming foundation design of the current on-site buildings is such that they do not create a viable pathway into the bedrock aquifer (i.e. they do not intercept the Chalk bedrock, and / or appropriate piling risk assessment was carried out and mitigation put in place, if required), the potential risk to the Chalk aquifer is considered to be low. |

Ecological

| | | |
|-----------------|-----|--|
| Flora and fauna | Low | Limited potential sources of contamination have been identified at the site, largely confined to the current AGS facility and Ringbrough Farm. Procedures for management, storage and handling of hazardous substances at the AGS facility are in place and the potential for widespread or gross contamination to be present is considered to be low. Furthermore, most of the historical buildings at Ringbrough Farm have already been lost to coastal erosion, including the potential 'unspecified tanks' identified by Atkins in 2022, so the potential for residual contamination to be present in this area is reduced. The potential for complete pollutant linkages to be present between the site and identified ecological receptors is therefore considered to be low. |
|-----------------|-----|--|

Buildings & Infrastructure

| | | |
|-------------------------|----------|--|
| Below-ground structures | Very Low | Limited information is available on the design and layout of the buildings currently present at the site. However, given that the only occupied buildings (i.e. the AGS facility) were constructed in the 2000s it is assumed that appropriate consideration was given to potential ground contamination and mitigation measures, if required. Furthermore, limited potential sources of contamination have been identified at the site and the potential for ground gas is also |
|-------------------------|----------|--|

| Identified Receptor | Potential Risk | Explanation |
|---------------------|----------------|---|
| | | considered to be low. Overall, the potential risk to buildings and infrastructure at the site is considered to be very low. |

9. SUMMARY

ERM has undertaken a Phase 1 Environmental Site Assessment of the 'Aldbrough Hydrogen Pathfinder' site to provide a preliminary assessment of the ground conditions and potential for contamination at the site.

Taking into account the site's environmental setting, available information on the site history and regulated activities in the vicinity of the site, ERM considers the overall potential risk to the identified receptors to be:

- Human health (site users, users of neighbouring properties): Very Low to Low;
- Surface waters (Cess Dale and East Newton Drains, North Sea): Low to Low / Moderate;
- Groundwater (superficial and bedrock aquifers): Low;
- Ecological receptors: Low; and
- Buildings & infrastructure: Very Low.

REFERENCES

- BGS (no date), *Landslides and coastal erosion at Aldbrough, East Riding of Yorkshire*. Available online at: <https://www.bgs.ac.uk/case-studies/landslides-and-coastal-erosion-at-aldbrough-east-riding-of-yorkshire-landslide-case-study/>.
- British Geological Survey, 1998, *Map Sheet 73: Hornsea, Solid & Drift, 1:50,000 scale*. Available online at: <https://webapps.bgs.ac.uk/data/maps>
- British Geological Survey, *GeoIndex Onshore*. Available online at: <https://mapapps2.bgs.ac.uk/geoindex/home>.
- Department for Environment, Food and Rural Affairs, *Magic Map Application*. Available online at: <https://magic.defra.gov.uk/magicmap.aspx>.
- Environment Agency / Department for Environment, Food and Rural Affairs, *Catchment Data Explorer*. Available online at: <https://environment.data.gov.uk/catchment-planning/>.
- Environment Agency, *Land Contamination Risk Management (LCRM)*, October 2020 (revised April 2021)
- Heritage Gateway (2012), *Historic England Research Records – Ringbrough Battery*. Available online at: https://www.heritagegateway.org.uk/Gateway/Results_Single.aspx?uid=915262&resourceID=19191
- Natural England (2010), *Agricultural Land Classification Yorkshire and The Humber (ALC003)*, 1:250,000 scale.
- The Coal Authority, *Interactive Map Viewer*. Available online at: <https://mapapps2.bgs.ac.uk/coalauthority/home.html>)
- UK Government, *Flood Map for Planning*. Available online at: <https://flood-map-for-planning.service.gov.uk/>.
- UK Health Security Agency (UKHSA), *UK Maps of Radon*. Available online at: <https://www.ukradon.org/information/ukmaps>.
- UK Soil Observatory, *Soilscapes*. Available online at: <https://mapapps2.bgs.ac.uk/ukso/home.html>.
- Zetica (2024), *Risk maps*. Available online at: <https://zeticauxo.com/downloads-and-resources/risk-maps/>



ERM HAS OVER 160 OFFICES ACROSS THE FOLLOWING
COUNTRIES AND TERRITORIES WORLDWIDE

| | |
|------------|-----------------|
| Argentina | The Netherlands |
| Australia | New Zealand |
| Belgium | Peru |
| Brazil | Poland |
| Canada | Portugal |
| China | Romania |
| Colombia | Senegal |
| France | Singapore |
| Germany | South Africa |
| Ghana | South Korea |
| Guyana | Spain |
| Hong Kong | Switzerland |
| India | Taiwan |
| Indonesia | Tanzania |
| Ireland | Thailand |
| Italy | UAE |
| Japan | UK |
| Kazakhstan | US |
| Kenya | Vietnam |
| Malaysia | |
| Mexico | |
| Mozambique | |

ERM's London Office
2nd Floor, Exchequer Court
33 St Mary Axe
London
EC3A 8AA

T: +44 (0) 20 3206 5200

www.erm.com