

## **31 GEOLOGY, HYDROGEOLOGY AND GROUND CONDITIONS**

### **31.1 INTRODUCTION**

31.1.1 This chapter addresses the issue of geology, hydrogeology and ground conditions and details the assessment to the potential impacts which are specific to the Compensation Site. The geology, hydrogeology and ground conditions of the AMEP site are covered in *Chapter 7*.

### **31.2 LEGISLATION, POLICY AND GUIDANCE**

31.2.1 Legislation, policy and guidance on geology, hydrogeology and ground conditions are common to both the AMEP and the Compensation Site and are covered in *Chapter 7*. There are no specific local policies relating to geology within the ERYC Holderness Wide District Local Plan.

### **31.3 ASSESSMENT METHODOLOGY AND CRITERIA**

#### *Overview*

31.3.1 The methodology for assessing the impacts on geology, hydrogeology and ground conditions at the Compensation Site are consistent with that used in the assessment of the AMEP site as detailed in *Chapter 7*.

### **31.4 CONSULTATION**

31.4.1 Consultation comments received that relate to geology, hydrogeology and ground conditions at the Cherry Cobb Sands part of the Compensation Site are detailed in *Annex 2.2* together with the response detailing how the comments have been addressed within the Environmental Statement.

### **31.5 BASELINE**

#### *Overview*

31.5.1 This section has been informed by both a desk study and an initial Site Investigation at Cherry Cobb Sands which has been undertaken to inform the Environmental Statement. The results from these investigations are summarised in the paragraphs below; further details are presented in *Annexes 31.1, 31.2 and 31.3*.

31.5.2 *Annex 31.1* prepared in December 2010 provides a desk study review of information on soil conditions around the Cherry Cobb Sands site that was used to inform the scope and design of a Site Investigation carried out in February 2011. *Annex 31.2* provides a factual report of the findings of the Site Investigation and *Annex 31.3* provides an interpretive report on these findings and their implications for the design of the Cherry Cobb Sands managed realignment. *Annex 31.3*, which benefits from the Site Investigation, takes precedence over *Annex 31.1* if there is any conflict.

#### ***General Description of Cherry Cobb Sands***

31.5.3 A detailed topographic survey of the Cherry Cobb Sands site undertaken in October 2010 showed that the land is relatively flat and low lying with a typical ground elevation of around 2.5 mAOD.

31.5.4 The site at Cherry Cobb Sands is predominantly agricultural land and there is no evidence of any recent industrial activity. Just outside the boundary of this site lies a historic landfill site (named "Land West of Cherry Cobb Sands Road"). Further details are given below.

#### ***Geology at Cherry Cobb Sands***

31.5.5 An assessment of the geology of the site and the ground conditions of Cherry Cobb Sands are reported in the *Summary Desk Study and Site Investigation Design Report (Annex 31.1)* and outlined below. The assessment of geology is based on the 1:50 000 Sheet 81 for Patrington (BGS 1991), the BGS geological memoir, *Geology of the Country around Grimsby and Patrington* (Berridge & Pattison, 1994) and intrusive investigations undertaken at the site (*Annex 31.3*).

31.5.6 Cherry Cobb Sands is underlain by marine and estuarine alluvium over glacial till over Cretaceous chalk.

31.5.7 The geological map for the area shows that the site is located on land that has been reclaimed from the Humber Estuary by natural and anthropogenic processes since the eighteenth century (BGS, 1991).

31.5.8 The marine and estuarine alluvium at Cherry Cobb Sands is likely to be around 20 to 25 m thick. In this part of the Humber Estuary these deposits are generally granular and comprise fine grained sands, silts and gravels with shell fragments. These granular soils are thought to be part of an ancient sand bank which extends across much of Sunk Island.

- 31.5.9 The granular soils are overlain by a 1 m to 5 m thick stratum comprising laminated silty clays and sands with organic layers. These cohesive strata were probably deposited in the last 400 years as a result of land reclamation, estuarine tidal deposition and saltmarsh development.
- 31.5.10 The glacial till below the alluvium is likely to comprise stiff gravelly clay and, due to the thickness of marine and estuarine alluvium, is unlikely to be encountered during the proposed construction works at the site.
- 31.5.11 Further below the glacial till, the Cretaceous chalk bedrock is unlikely to be encountered during the works due to its significant depth.

### *Hydrogeology at Cherry Cobb Sands*

- 31.5.12 The marine and estuarine alluvial deposits at Cherry Cobb Sands are recorded as a non-aquifer on the Groundwater Vulnerability Map of the area (NRA, 1994). From 1 April 2010, aquifer designations were adopted in England and Wales that are consistent with the Water Framework Directive and, in accordance with the Directive, the marine and estuarine alluvial deposits in this area are likely to be classed as “unproductive strata”.
- 31.5.13 The foreshore and saltmarsh areas on the seaward side of the existing flood defences at Cherry Cobb Sands (NGR TA 210220) and to the east of Stone Creek (NGR TA 240185) are recorded on the Groundwater Vulnerability Map as being minor aquifers comprising soils with a high leaching potential. In accordance with the Water Framework Directive these areas would be classed as “Secondary Aquifers”, although, due to the likely brackish water and limited thickness of the strata, it appears unlikely that they could support groundwater supply.
- 31.5.14 Whilst the marine and estuarine alluvial deposits are not expected to be an aquifer with potential as a groundwater resource, they are likely to be water bearing. The groundwater level is thought to be near to the ground surface across much of the site and is likely to be in hydraulic continuity with the adjacent Humber Estuary; groundwater levels and pore water pressures may therefore fluctuate as river water levels vary due to tidal and other influences.

## ***Contaminated Land at Cherry Cobb Sands***

### *Within the Cherry Cobb Sands Site*

- 31.5.15 Agricultural land in Yorkshire and the Humber region represents 69% (1 674 835 ha) of the total regional area (2 412 944 ha) (Farm Business Survey, 2009).
- 31.5.16 The land within Cherry Cobb Sands is Grade 2 agricultural land. The Agricultural Land Classification of England and Wales (MAFF 1988) defines Grade 2 as very good quality agricultural land which has: *'minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1.'*
- 31.5.17 The initial Site Investigation that was carried out to inform this ES found that the majority of the soils at the site do not contain visual or olfactory evidence of contamination and do not contain contaminants in elevated concentrations (*Annex 31.3*).
- 31.5.18 There could however be contaminants present in the soils which may be related to the current agricultural use of the land at the site and these could include pesticides, fertilisers and other agricultural chemicals. Such contaminants, if present, are likely to be relatively uniformly distributed across the site and will probably be confined to the topsoil. The fate of pesticides in the water environment is considered in *Chapter 33*.
- 31.5.19 The pre-application consultation response from Hickling Gray Associates indicates that former creeks within Cherry Cobb Sands may have been in-filled with industrial and commercial waste (*Annex 2.2*). These former creeks appear on old aerial photographs but are not recorded as historic landfill sites by the Environment Agency. An archaeological geophysical investigation undertaken (*Annex 40.3*) concluded that several former field divisions and channels had surprisingly high magnetic signatures, also suggesting that they may contain landfill.

### *Outside the Cherry Cobb Sands site*

- 31.5.20 The Desk Study assessment of the area identified one historic landfill site (Land West of Cherry Cobb Sands Road) on the northwest boundary of the Cherry Cobb Sands site (NGR TA 214214)

(Environment Agency, 2010a). The website does not contain any further information about the landfill but it is likely to have been in operation in the 1950's and 1960's.

- 31.5.21 The Site Investigation found that the soils within the landfill contain a variety of anthropogenic materials including possible asbestos (sheet fragments and wool) and have a 'very strong (overwhelming) VOC and hydrocarbon odour' (Annex 31.3). These soils were also found to contain high concentrations of metals and hydrocarbon contaminants.
- 31.5.22 No other active or historic landfills are recorded on the Environment Agency website within 1 km of the Cherry Cobb Sands site. However, the geological map of the area does record a back filled quarry or pit at NGR TA 220227, around 600 m north of the Cherry Cobb Sands site (BGS, 1991).
- 31.5.23 The Environment Agency website reports a minor pollution incident involving a spillage of contaminated water close to Stone Creek (NGR TA 235190) (Environment Agency, 2010a). No further information is provided.
- 31.5.24 Finally, the Environment Agency website records one company with a licence to discharge potential pollutants at Saltaugh Grange (NGR TA 239217) around 1.5 km north-east of the site. The licence allows the discharge to the atmosphere of particulate matter, ammonia and methane and the site was also used as a waste transfer station for used oils and food waste.
- 31.5.25 The foreshore to the north of the north western boundary of Cherry Cobb Sands was used as a decoy site during World War II. This involved the excavation of a series of ditches and pools on the seaward and also probably on the landward side of the embankments. Lights were erected in the area so that the pools and ditches resembled Hull Docks. Oil could also have been pumped into some of the pools and ignited to resemble burning buildings. This means that there is potential for pollutants such as hydrocarbons and heavy metals, along with unexploded ordnance (UXO) and general waste to be present in the pools on the seaward side of the embankments.

### ***General Description of Old Little Humber Farm***

- 31.5.26 The site at Old Little Humber Farm consists of four arable fields that are classified as Grade 2 agricultural land with no evidence of any recent industrial activity. The definition for Grade 2 land is given in *paragraph 31.5.16*.

- 31.5.27 There are no records of historic or active landfill sites on or close to Old Little Humber Farm. The Environment Agency groundwater vulnerability mapping indicates that the superficial deposits are undesignated as an aquifer.
- 31.5.28 No topographical level survey or site investigation has been carried out at this site.
- 31.5.29 The site at Old Little Humber Farm is crossed by three major gas pipelines and by two water pipelines serving local properties. In addition the route for the electricity cable supporting the Humber Gateway Project is planned to cross the site.

## **31.6**      *IMPACTS*

### *Construction Phase at Cherry Cobb Sands*

#### *Geology and Hydrogeology*

- 31.6.1 Cherry Cobb Sands and the surrounding area is not designated for its geological importance; therefore there will be no impact on any statutory or non statutory designated geological sites during the construction.
- 31.6.2 As the groundworks are likely to be limited to the surface 1 m to 2 m across the site, there will be no impact on the solid geology of the area.
- 31.6.3 Given the significant depth of the chalk aquifer it is unlikely that there will be any pathway for pollutants from leakages or spillages to enter the chalk aquifer.

#### *Contaminated Land*

##### *Within the Cherry Cobb Sands site*

- 31.6.4 Excavation of approximately 300 000 m<sup>3</sup> of material will be required to construct the new flood embankment (see *Chapter 28*). In order to source this material, the topsoil will be stripped and subsequently replaced back into the site, following excavation of material for the flood embankment. If polluted soils are present within the Cherry Cobb Sands site boundary then there is the potential for excavations to remobilise pollutants or contaminants within the soil. This could result in the flushing of pollutants into the estuarine waters following the breach. This impact is considered as part of water quality and sediment quality in *Chapter 33*.

31.6.5 Additional Site Investigations are proposed in the Contaminated Land Risk Assessment (*Annex 31.4*) prior to the commencement of construction works which will be designed to determine the presence, location and type of contamination within the boundary of the Cherry Cobb Sands site. In particular, these investigations will focus on the identification of any unrecorded landfill sites that may be present within the boundary of the site. This information will be used to inform the detailed design of the development. If contaminated material is found to be present, then a detailed risk assessment will be carried out to determine treatment, re-use and disposal options.

31.6.6 A desk study unexploded ordnance (UXO) risk assessment for the site has been undertaken by BACTEC International Ltd. This concluded that there is a medium risk of encountering UXO at the site. Mitigation measures to reduce this risk are detailed in *Paragraph 31.8.2*.

*Outside the Cherry Cobb Sands Site*

31.6.7 The ditches and pools seaward of the Cherry Cobb Sands embankment which may have been used as a decoy site, will not be disturbed during construction or operation and therefore there is no impact from pollutants which may be present in these areas.

***Construction Phase at Old Little Humber Farm***

31.6.8 The major construction activities at Old Little Humber Farm will be the re-profiling of the land to form wet grassland. The indicative site plan shows the maximum excavation below the existing land surface to be only 0.25 m so the majority of soil that is excavated to create wet grassland will be from within the plough depth of these fields which are currently in arable cultivation.

31.6.9 The depth of excavation at this site will be small, so the risk of encountering contaminated land is also considered small, especially as there are no known sites in the vicinity and none were reported during the excavations for the pipelines that cross this site. If contamination is found during the works, work would stop and a detailed risk assessment carried out as described in *paragraph 31.6.7*. For similar reasons, the risk of finding UXO is also considered small.

31.6.10 The precise alignment of the gas and water pipelines that currently cross the site will be carefully established prior to any works on the site. The route of the Humber Gateway cable will also be carefully established if it has been laid before construction starts. A buffer strip 5 m either side of these pipeline routes will be left at existing ground

level and load distributing mats used at crossing points to ensure that plant crossing the pipelines does not overload them. Therefore there will be a negligible impact during construction.

### ***Operational Phase***

#### *Geology and Hydrogeology*

- 31.6.11 Due to the works being limited to the surface 1 to 2 m, there will be no impact on underlying solid geology during the operation of the Compensation Site.
- 31.6.12 Given the significant depth to chalk rockhead it is unlikely that the proposed development at Cherry Cobb Sands will create any additional pathways for saline water to enter the chalk aquifer. The foreshore secondary aquifer in this area is also unlikely to be affected by the proposed development. Therefore, the impacts on hydrogeology are considered to be of negligible significance (see *Chapter 33* for further detail).

#### *Agricultural Land*

- 31.6.13 Creation of the Compensation Site will result in the loss of approximately 153 ha of Grade 2 agricultural land from arable production, though 38 ha will return to arable production when the wet grassland at Old Little Humber Farm is no longer needed to provide functioning habitat for birds. This loss of 153 ha equates to 0.009 percent of the total agricultural land available in the region, while the recovery of 38 ha equates to 0.002 percent. Therefore, considering the local, regional and national extent of Grade 2 land, the loss of this soil resource is assessed as being of low magnitude. The sensitivity of the soil resource is assessed as being medium as the land is of very good quality, but not the best quality. The resulting effect is a permanent moderate negative significant impact. The social and economic impacts associated with the loss of this land are addressed in *Chapter 42*.

## **31.7 CUMULATIVE IMPACTS**

### ***Construction Phase***

- 31.7.1 The effects on geology, hydrogeology and ground conditions of other developments on the south bank do not have the potential to cause cumulative impacts during either construction or operation of the Compensation Site.



- 31.7.2 Of the proposed developments on the north bank, only the onshore cable route of the Humber Gateway project may be constructed at the same time as the Compensation Site. Construction will cross the Old Little Humber Farm site. If the cable is laid before the wet grassland is developed the cable route will be marked and avoided by leaving a 10 m buffer strip along the route. If the works at Old Little Humber Farm are constructed first, a 10 m strip will be left at original ground level along the planned route of the cable for later installation.
- 31.7.3 It is very unlikely that there will be any effects to geology and hydrogeology from the installation of the cable given the significant depth of the solid geology and aquifer. Impacts on ground conditions from this development will be limited to the immediate area of excavation and will not result in a cumulative impact with the Compensation Site.

### *Operation Phase*

- 31.7.4 There are a number of developments on the north and south banks of the Humber which will result in the loss of agricultural land as shown in *Table 31.1*. The total losses of the soil resource combined with the Compensation Site are 904.2 ha, including the agricultural land lost as a result of the AMEP development. 303.8 ha of this land is of the best quality (Grade 1 and 2). The total loss of agricultural land would reduce to approximately 771 ha (204 ha of Grade 1 and 2 land) once the wet grassland at Old Little Humber Farm and the cable route for the Humber Gateway project are returned to arable use.
- 31.7.5 Loss of this total resource, including losses from all other developments (where known) and the Compensation Site equates to 0.05 percent of the total agricultural land available in the region (1 674 835 ha in Yorkshire and the Humber region). In the context of the availability of good quality agricultural land on a local, regional and national extent the loss of the soil resource is assessed as being of low magnitude. The sensitivity of the soil resource is assessed as being medium as described in *Paragraph 31.6.13*. The resulting effect is a permanent moderate negative significant impact. The social and economic impacts associated with the loss of this land are addressed in *Chapter 42*.

**Table 31.1 Potential loss of agricultural land from other developments**

<b>Development (planning reference)</b>	<b>Agricultural land (ha)</b>	<b>Grade</b>
Humber Gateway onshore installation (08/01993/STPLFE)	95.0 (temporary loss)	65% of land Grade 2. No details on remaining 35%.
Bioethanol plant (PA/2006/1880)	6.9	3a and 3b
Able Area F (PA/2008/1463)	5	Not stated.
Ursa glass wool factory (PA/2008/0988)	25	Not stated.
Able Northern Area (PA/2009/0600)	379.9	Not stated.
Donna Nook Managed Realignment Site (N/132/02687/09)	89	Predominantly Grade 1 and Grade 2.
AMEP development	150.4	3

## **31.8 MITIGATION MEASURES**

### ***Construction Phase***

- 31.8.1 Prior to excavation of material within the Cherry Cobb Sands site a further intrusive Site Investigation of potential landfill areas will inform the risk of encountering contaminated sediments (*Annex 31.4*). Consultation with farmers will also help to determine the type of pesticides and fertilisers which have been used on the site. This will inform the selection of locations to excavate and will determine the likely level of chemicals entering estuarine waters following breaching of the site.
- 31.8.2 Mitigation measures to reduce the risk of encountering UXO at the Compensation Site are included in the BACTEC UXO desk study risk assessment. These include non intrusive geophysical UXO surveys prior to the commencement of the earthworks and visual inspections of open excavations by a suitably qualified engineer. An emergency response plan will be produced which will cover the correct procedures should UXO be discovered on site.

### *Operational Phase*

- 31.8.3 Other than ensuring that Cherry Cobb Sands is carefully designed to avoid erosion in areas of potential contamination identified through further site investigation, mitigation for operational impacts associated with the Compensation Site is not required.

## **31.9 RESIDUAL IMPACTS**

### *Construction Phase*

- 31.9.1 Whilst a further intrusive Site Investigation will be undertaken prior to construction to identify the presence of any unrecorded historic landfills within the Cherry Cobb Sands site boundary, there remains the potential for discovery of an area of undiscovered contaminated land during construction at the Compensation Site. If this occurs, machine operators will stop immediately and report any encounter with suspected contaminated material to the Site Manager (*Annex 31.4*). The suspect material will be assessed to determine treatment, re-use and disposal options.
- 31.9.2 The risk of encountering UXO can never be completely mitigated and there remains potential for discovery of UXO during construction. If appropriate mitigation measures as detailed in *Paragraph 31.8.2* are put in place the risk is considered to be reduced as far as is practicable. This will result in a remaining high sensitivity, but will reduce the magnitude to low, resulting in a potential moderate negative significant effect.

### *Operational Phase*

- 31.9.3 There is residual impact on agricultural land and loss of the soil resource which is assessed as being a permanent moderate negative significant impact.