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19 GEOLOGY, HYDROLOGY AND LAND QUALITY

19.1 Introduction

This section details the existing geology, hydrology, hydrogeology and land quality in the vicinity of the onshore works including the landfall site, cable route and substation extension. The potential impacts from construction, operation and decommissioning activities of the Thanet Offshore Wind Farm (Thanet) project are assessed, and where necessary, mitigation measures have been identified.

19.2 Assessment Methodology

A desktop study has been undertaken involving the collation and review of existing information from the following main data sources:

- Geological Map Sheet 274: Ramsgate, Solid & Drift Edition, British Geological Survey, 1980;
- Geology of the country around Ramsgate and Dover, 1988;
- Sandwich Bay and Hacklinge Marshes SSSI citation; and
- The North East Kent European Marine Sites, Management Scheme.

Publicly available information on land quality, historic use, hydrology and regulatory consents has also been obtained from the Environment Agency and the Local Planning Authority (Landmark Information Group Ltd, 2005).

19.3 Existing Environment

19.3.1 Geology

The Isle of Thanet is underlain by Upper Chalk, which is a soft white limestone formed in tropical seas and largely composed of the remains of microscopic planktonic algae. To the north of the Isle of Thanet it is underlain by deposits of Brickearth, which is largely derived from loamy parent rock from the Thanet Beds. To the west and south of a line from Monkton to Cliffs End, the Chalk is in uncomfortable contact with the overlying Thanet Sand Formation, which comprises fine grained grey and brown sands with local silty clays and abundant marine shells. The Thanet Sand Formation is overlain by alluvial deposits in the old Wantsum Channel and the River Stour floodplain.

The Chalk emerges at the coastline to form cliffs and an extensive wave-cut platform from Grenham Bay to Ramsgate. The Chalk contains important fossils such as sponges and sea urchins in Pegwell Bay. The juncture between the Upper Chalk and the Thanet Sand Formation at Cliffs End is a nationally important geological Site of Special Scientific Interest (SSSI).

With respect to the landfall, the geological map indicates that immediately to the north of the landfall location, the Thanet Sand Formation is exposed at the cliff face (Pegwell Bay cliffs) with an overlaying layer of Head Brickearth.

The geology of Pegwell Bay to the south of the landfall is characterised by marine beach deposits and tidal flats. Inland, the deposits are marine and estuary alluvium comprising

mainly of silty clay. The geological map indicates that there is an area where drift deposits are absent between Cottington Hill and Stonelees.

The surface deposits including marine beach deposits, marine and estuary alluvium overlay the Thanet Sand Formation, which in turn overlies Chalk. Details from Ebbsfleet borehole, which is located less than 500m from the existing electrical substation at Richborough Power Station, indicate that Thanet Sand Formation is present to a depth of 33.5m and Chalk extends to a depth of some 240m.

19.3.2 Geological designations

The coast from Pegwell Bay to Hacklinge Marshes is designated as Sandwich Bay and Hacklinge Marshes SSSI for biological and geological reasons. With respect to geology, Pegwell Bay is of geological importance for the following reasons:

"The Thanet Formation contains an important fish fauna…. there is no other Thanetian site in Western Europe with this diversity of fauna, which includes many, as yet undescribed species plus the earliest records of other known Tertiary forms. The outcrop has very great significance because it is the only outcrop, which shows the bottom living fish assemblage, which was subsequently destroyed by the North Sea volcanicity, for the ash falls by these volcanoes brought about an extinction event....."

"At Pegwell Bay the Upper Chalk is overlain by the basal Tertiary beds of the Thanet Sands. The junction is marked by the celebrated "Bull-head Bed", an in situ weathering residue of unabraded flint nodules. This is a key section showing a demonstrable and regionally significant unconformity. Pegwell Bay is also the most important site for loess studies in Britain. The section shows up to 4m of Devensian loess overlying Upper Chalk and Thanet Beds. The loess, an accumulation of wind-blown dust produced under periglacial conditions during the Ice Age, is probably thicker here than at any other site in Britain, and is certainly the most closely studied example. …" (Pegwell Bay to Hacklinge Marshes SSSI citation)

19.3.3 Hydrology

The nearest surface watercourses are the River Stour, which runs to the east of the A256 Sandwich Road into Pegwell Bay, and the Minster Stream, located close to Richborough Power Station. The River Stour is tidally influenced to approximately Richborough Industrial Estate.

Both the River Stour and the Minster Stream are classified as main rivers by the Environment Agency. Prior consent will be required from the Environment Agency should the onshore cable route pass beneath either watercourse. In addition, any works within 8m or 15m of a tidal or non tidal main river respectively, will require Environment Agency consent. The Environment Agency will not normally consent works, which obstruct these Byelaw margins (EA correspondence, 6th July 2004). In addition, there are a number of drains in close proximity to the A256 Sandwich Road along the onshore cable route.

There are no tidal defences in place at the landfall location. The onshore cable route and substation extension are within an area classified by the Environment Agency as at

risk of tidal flooding, falling within the 1 in 200 year flood risk boundary (see www.environment.agency.gov.uk).

Baseline Water Quality data for the River Stour have been collected for the A256 East Kent Access Improvement Environmental Impact Assessment (Babtie, 2000). Chemical water quality on the River Stour was classified as 'good' according to the GQA Grading Scheme for Rivers and The Surface Water (River Ecosystem Classification) Regulations 1994.

According to information supplied by the Environment Agency, there are no consented discharges in the study area.

There is one abstraction licence within 250m of the onshore cable route, and a further six that fall within 2km of the route. These are shown in **Table 19.1**.

Table 19.1 Abstraction licenses within 2km of onshore cable route

Licence No.	Licence Holder	NGR / distance from cable route	Source	Period of abstraction	Purpose	Authorised licence quantities
09/183	Dyas Farm Ltd	TR 334 623 / 165m TR 332 627 / 500m	Watercourse at Ebbsfleet	1 Apr to 30 Sep	Spray irrigation (direct)	18m^3/hr 250m^3/day 9,188m^3/yr
9/40/04/04 42/S	Edward Spanton Farms	TR 339 637 / 370m	Ebbsfleet Stream at Cliffs End	1 Apr to 31 Oct	Spray irrigation (direct)	55m^3/hr, 546m^3/day, 14,811m^3/yr
09/179	Ebbsfleet Stonelees Golf Centre	TR 338 636 / 370m	Drainage dyke north east of B2048	1 Apr to 31 Oct	Spray irrigation (storage)	18m^3/hr, 432m^3/day, 5,000m^3/yr
9/40/04/00 29/A/GR	Tapp	TR 332 630 / 600m	Borehole at Ebbsfleet Farm	All year	General farming and domestic	9.1m^3/hr, 34.5m^3/day, 12,611m^3/yr
9/40/04/05 38/S	Messrs. Robertson	TR 331 630 / 700m	Watercourse at Ebbsfleet	1 Apr to 30 Sep	Spray irrigation (direct)	25m^3/hr, 380m^3/day, 12,280m^3/yr
09/182	Robertson	TR 327 630 / 1km	Minster Stream and tributaries at Minster Marshes	1 Nov to 31 Mar	Spray irrigation (storage)	70m^3/hr, 1,140m^3/day, 30,510m^3/yr
9/40/04/00 49/GR	Southern Water	TR 353 651 / 800m TR 374 661 / 2.5km	Borehole at Whitehall PS	All year	Public water supply	972m^3/hr, 14,774m^3/day, 4,091,400m^3/yr

19.3.4 Hydrogeology

The surface drift deposits present along the onshore cable route have a high capacity to transmit water. The Thanet Sand Formation is classified by the Environment Agency as a minor aquifer, whilst the Chalk is classified as a major aquifer of regional importance.

Regional groundwater flow in the area is directed towards the east and the English Channel. However, close to the substation, the groundwater flow may be locally

diverted towards the west and the River Stour. In general it is likely that the groundwater in the area is tidally influenced.

No groundwater source protection zones are found along the cable route and substation extension (see www.environment-agency.gov.uk). In fact, given the proximity to the coast, it is possible that the groundwater underlying the area is brackish.

19.3.5 Land quality

Pegwell Bay historic landfill site

According to current records there is an historic landfill site adjoining the A256 Sandwich Road (NGR TR 342 632), which falls within the Pegwell Bay National Nature Reserve. The site fill is thought to have included putrescible and difficult waste, with some slow degradable matter (Environment Agency correspondence, 28th July 2005).

Disused hoverport

The site of the former hoverport in the northern part of Pegwell Bay (see **Figure 2.13**) was reclaimed from mudflats using engineered colliery shale waste. Ground contamination has been reported on the site through ground investigations using boreholes and spike samples. Elevated concentrations of magnesium, copper, and sulphate are reported associated with the colliery fill material. Elevated concentrations of hydrocarbons have been detected in groundwater and these are likely to have emanated from former fuel storage and vehicle maintenance areas (Geo-Environmental Services Ltd, 2004).

Contamination is reported to have no significant impact on the current site usage, and would not preclude a variety of possible future land uses, however, it is also reported that the site was considered likely to be classified as Contaminated Land under Part IIa of the Environment Act, due to the risks associated with groundwater contamination discharging to coastal waters.

Further investigations conducted on the site assessed the risks associated with groundwater discharges to coastal waters, and these included assessment of the containment structures along the seafront, quantification of the potential for future contaminant leaching from within the subsurface and recommendations in the form of a remedial strategy for the site. Concrete aprons bordering the site are in good condition for their age with only minor reinforcement corrosion and cracking. However, rock armour in the north of the site has undergone degradation, as has the central outfall. Samples taken from coastal sediments and water indicated that significant concentrations of hydrocarbons were recorded in locations around the central outfall and also in control samples north of the site. A water sample from the cracked concrete apron also contained elevated concentrations of aliphatic and aromatic hydrocarbons. These results indicate that contaminated groundwater is migrating into the coastal waters (Geo-Environmental Services Ltd, 2005).

19.4 Impacts during Construction

19.4.1 Effects on the Pegwell Bay to Hacklinge Marshes Geological SSSI

The following options are under consideration for the landfall connection and are illustrated in **Figure 2.13** and **Plate 19.1.**

- The preferred option would be to route the cable via open cut installation across the beach and a short section of shoreline, along the bank and then routed into the joint transition pit at the top of the cliffs, in a corner of the arable field above the hoverport.
- The alternative would involve directional drilling from the joint transition pit to a suitable exit point on the beach. Ducts would be installed along the line of the directional drill to allow the export cables to be pulled through and the joint made in the joint transition pit.

Either construction methodology would ensure that the cliff's geological exposures are not affected. The working area of the cable route will be demarcated via fencing to ensure that no construction plant movement or storage occurs within the SSSI.

No additional effects to the geological interest of the SSSI would be anticipated given directional drilling.

Plate 19.1 Location of landfall

19.4.2 Effects on hydrogeology and groundwater

The export cable route would emerge from Pegwell Bay approximately 300m from the northern corner of the former hoverport site. The cables would pass along the beach and ascend the cliff through an open cut trench where they would enter a joint transition pit. The underlying geology at the point where the cables emerge and ascend the cliff is identified as Thanet Sand Formation. Considering the hydrogeological classification of

the formation as a minor aquifer and the relatively high migratory potential for groundwater through this type of medium, it is considered that the impact of cutting a trench in the beach and cliff is likely to have minimal impact on the groundwater flow. As a substantial pathway for contamination between the groundwater and Pegwell Bay between the northern border of the hoverport and the cable trench already exists, the excavation of the beach and sandstone geology and groundwater would not have any additional adverse effects.

Considering the nature of the contamination within the groundwater beneath the hoverport and the proposed remedial plans, it is considered that there is no significant increase in risk associated with the construction of the cable route in terms of hydrocarbon contamination emanating from the hoverport entering Pegwell Bay.

Due to the influence of the tidal cycle on the movement of groundwater in the area that is moving inland with a flood tide and towards the Bay on the ebb tide, the cable would not restrict any groundwater movements.

Considering the sensitive nature of the Bay, as a precautionary matter, any groundwater encountered whilst constructing the cable route will be sampled for hydrocarbon contamination and any significant results reported to the Local Authority and the Environment Agency. Overall, a **minor adverse** impact is predicted.

19.4.3 Effects on hydrology

The onshore cable route does not pass under or near the River Stour, however, there are a number of drains that are in close proximity to the A256 Sandwich Road and the Minster Stream runs under the carriageway just to the north of the entrance to Richborough Power Station. To ensure that water quality is not affected during the installation of the cables, the following pollution prevention guidance (PPG) documents from the Environment Agency will be adhered to and will form part of the construction method statement:

- PPG1 General Guidance for the Prevention of Water Pollution;
- PPG5 Works in, Near or Liable to Affect Watercourses;
- PPG6 Working at Construction and Demolition Sites;
- PPG8 Safe Storage and Disposal of Used Oils; and
- Control of Water Pollution from Construction Sites – A Guide to Good Practice (CIRIA 2001).

Depths of excavation during construction would vary from 1.1m for the onshore cables and up to 3m for the joint transition pit. This depth of excavation would not have any effect on the hydrogeology of the area, since aquifers in the area are located at a depth greater than 240m.

Liaison with the Environment Agency will be undertaken regarding the installation of the onshore cable route in the vicinity of Minster Stream in terms of the need for consent under the Water Resources Act 1991.

Given successful implementation of the measures cited above, **no impact** is anticipated upon the hydrology of nearby watercourses or hydrogeology.

19.4.4 Impacts on the soil from trenching/drilling procedures and laying of the cable

Accidental spillages of fuels or oils from vehicles or the directional drilling rig could have potentially adverse impacts on local soil or groundwater. The magnitude of these impacts are anticipated to be of a small scale and localised with short term duration, providing that spills are cleaned up on detection. The following good construction practice measures will be adopted:

- Adherence to advice provided in the Environment Agency's 'Pollution Prevention Guidelines' on working at construction sites and near water bodies;
- Any spillage of fuel or chemicals that occur will be cleaned up immediately and the Environment Agency informed if appropriate; and
- Equipment will be used in accordance with the manufacturer's recommendations, including servicing frequencies to ensure optimum operation.

The impact, given implementation of the above measures, is considered to be **negligible.**

19.4.5 Impacts of remobilisation of soils and contaminants during construction

The desktop review of land quality has not identified any areas of significant contamination, which would be directly affected by the onshore cable route. The historic landfill site adjacent to the A256 Sandwich Road (NGR TR 342 632) is located some 175m from the cable route within the Pegwell Bay National Nature Reserve. Works are not expected to encroach into this area. There may however, be a potential for landfill gas migration depending on a number of factors. It is understood that Kent County Council's Geotechnical Group monitor for landfill gas migration and groundwater contamination by leachate.

The site specific ground conditions are unknown within the vicinity of the substation, which requires some minor extension and additional infrastructure in the form of access roads. Although the former power station was fuelled by coal and later by orimulsion, this material was stored within bunds and tanks at the far northern part of the site. It is considered that there is a low potential for contamination to be present in the area of the substation and access road from spillages and leaks or contamination migration.

Should contamination or landfill gas be present, the receptors that may be significantly harmed or at risk by potential contaminative materials being disturbed by excavation works are considered to be:

- Construction workers: Considered to be a sensitive receptor due to the close proximity in which they are required to work with contaminated materials;
- Buildings and structures: Considered to be a sensitive receptor, as there may be a potential for chemically aggressive ground conditions and soil gas;

- Shallow groundwater within the gravel layers of the Alluvium: Considered to be a low sensitivity receptor given that the alluvium is classed as a non-aquifer. It should be noted however, that this groundwater is likely to be in hydraulic continuity with the River Stour;
- Deep groundwater within the Chalk aquifer: Considered to be a sensitive receptor; and
- Surface waters (e.g. River Stour): Considered to be a sensitive receptor. Given that the groundwater within the alluvial deposits my be hydraulically continuous with this water body, any contamination which impacts the groundwater may migrate towards the river and impact its quality. However, it is possible that there is limited flow within the alluvium and dilution within the shallow groundwater and the surface water body itself may reduce the associated risks.

Given the potential for some risk to the above stated receptors, an intrusive site investigation will be undertaken prior to construction within the substation extension area to determine the actual risks and, where necessary, determine the measures required to ensure that there is no significant risk to both on and off site receptors.

The site investigation will be discussed with the Local Planning Authority and where necessary with the Environment Agency and could include the excavation of a number of exploratory holes to determine the ground and groundwater conditions and the taking of soil and groundwater samples for chemical analysis.

The impact, given implementation of the above measures, is considered to be **negligible**.

19.4.6 Impacts of disposal of construction wastes

The majority of the soil arising from the trench construction would be replaced following the installation of the onshore cables therefore the amount of waste to be removed from site would be minimal.

The horizontal directional drilling process, if required, may result in the generation of some construction wastes. The storage and disposal of this waste may create a potential adverse impact in localised areas of relatively short term duration. Regarding storage and disposal of any arisings, the following good construction methods will be adopted:

- The Contractor will have a Duty of Care with regard to any waste generated on site, meaning that they will be responsible for the safe storage, transportation and eventual disposal of the waste;
- Waste will be stored in designated areas away from surface water drains. Skips will be covered to prevent rainwater accumulation and waste/litter blown out;
- Wastes will be segregated to avoid potential cross contamination by ‘contaminated’ and ‘inert’ wastes where appropriate;
- No burning or disposal of wastes on site will take place; and
- Any waste carriers and receiving landfill sites will be registered.

The impact, given implementation of the above measures, is considered to be **negligible**.

19.5 Impacts during Operation

The onshore cable route would be buried at a minimum depth of 1.1m. The cables would be insulated and protected in order to ensure minimum maintenance requirements. Therefore, there would be no potential for soil contamination, compaction or erosion resulting from the operational phase of the cable route. Some routine maintenance would be required for the substation equipment which would involve inspection of new switchgear. Good practice and pollution prevention and control measures will be taken to avoid any spillages or contamination. **No impact** is anticipated.

19.6 Impacts during Decommissioning

After the end of the cable's working life, it is anticipated that it will be disconnected and left in situ in order to reduce environmental impacts, unless otherwise advised by the Local Planning Authority. It is also likely that any equipment installed within the substation extension would remain in place. Therefore **no impact** is anticipated.

19.7 Cumulative Effects

No cumulative effects are anticipated.

19.8 Summary

Information on the geology, hydrology, hydrogeology and land quality in the vicinity of the landfall site, onshore cable route and substation extension was collated in order to assess any impacts from the construction phase on these resources.

There are a number of interest features in the area, including a Site of Special Scientific Interest (SSSI) designated for its geological interest, aquifers at depth and nearby main rivers and watercourses. The construction activities would not, however, directly impact on any of these features due to distance separation. The working area of the onshore cable route will be demarcated with fencing to ensure that this remains the case. Pollution prevention guidance will also be adhered to as part of good construction practice and be incorporated into a Method Statement.

Potential areas of historic contamination such as the substation extension will be subject to a site investigation to ensure that any contaminated material disturbed as a result of excavations or other construction activity does not pose a risk to nearby sensitive receptors or construction workers.