6 GEOLOGY AND HYDROLOGY

6.1 Introduction

The aim of this section is to identify and assess the significance of potential effects of the wind farm development on the hydrology, hydrogeology and geology of the area during the construction, operational and decommissioning phases, and where necessary to devise mitigation strategies. Mitigation measures to reduce or negate potential adverse impacts are identified and the following key issues are considered in relation to the development:

- Impacts on water quality and water supplies
- Modifications to natural drainage patterns
- Impacts on groundwater
- Impacts on flow in natural watercourses
- Disturbance to the hydrological characteristics
- Abstractions
- Impacts on the local geology
- Pollution risk

6.2 Summary

The proposed wind farm development overlies shallow superficial geology over a major aquifer of high permeability and is located within a groundwater source protection zone, therefore the geology and hydrogeology of the area is vulnerable. Furthermore there is a SSSI adjacent to the site. The southern half of the site is underlain by Boulder Clay with the remainder of the site underlain directly by Middle and Upper Chalk. Chalk outcrops may contain dissolution features that may cause future subsidence or collapse if built upon. Further, if structures are placed on or near to partially infilled dissolution features, these may be reactivated if changes in surface drainage patterns occur as a result of construction.

As such, there is an inherent risk to groundwater, surface water, ecological resources and geology during the construction and operational phases. While there are no identified former contaminative uses of the site, appropriate diligence and mitigation measures will be adopted. Specific recommendations include:

- A Foundation Works Risk Assessment will be completed and agreed with the Environment Agency prior to construction.

- A Site Investigation will be conducted to assess the risk of dissolution features.

- During the construction phase, the removal or displacement of soil for the foundation construction and cable laying, or other construction activities is considered to be of **moderate** risk. Chalk fines may result in significant suspended particulate loading to the drainage channel. Mitigation measures will be incorporated during the construction phase in order to reduce impacts related to soil compaction and increased sedimentation and to prevent the occurrence of potential contamination or pollution incidents impacting upon surface water. This will include the use of Environmental Best Practice and

appropriate construction methodologies, and adherence to Environment Agency Pollution Prevention Guidelines.

During operation, no significant impact is anticipated on geological resources and groundwater. In addition, the presence of the turbine foundations and on-site access tracks are not anticipated to affect the site drainage or increase flood risk. However, due diligence and pollution prevention measures will be applied, including the following:

- Oil and fuel tanks will be stored in a designated area in accordance with the EA Pollution Prevention Guidelines, PPG2 Above Ground Oil Storage tanks and in compliance with the Control of Pollution (oil Storage) (England) Regulations 2001.

- Storage tanks, containers and ancillary equipment will be placed within oil and watertight secondary containment such as bund. The secondary containment system will provide storage of at least 110% of the tanks maximum capacity.

- Secondary containments will be secured to avoid unauthorized access and vandalism.

- A contingency plan will be produced detailing site drainage and list of contacts in the event of a spillage in line with PPG21 Pollution Incident Response Planning. Spillages will be reported to the site manager immediately. A stock of absorbent material will be stored on the site to deal with spillages, and staff will be trained in their appropriate use

- Training of staff on the correct use and storage of all oils and chemicals on the site.

Although the proposed site is not at risk of flooding, during severe weather events, the northernmost turbines could be at risk of flooding from the overflow of the tributary to the River Granta. Such a possibility should be taken into consideration at the detailed design stage during ground investigations.

6.3 Assessment Methodology

The assessment of the geology and hydrology of the site included a one day site attendance by a Geo-Environmental engineer to carry out a walkover survey in order to assess the site topography and geomorphology, drainage, and proximate water supply patterns, combined with a desk study research.

The assessment includes the following tasks:

- Consultation with the Environment Agency and Local Planning Authority to gather available data and assess the potential impact to any nearby receptors;
- Review of topographic maps and aerial photographs to identify natural catchment areas;
- Review of available British Geological Survey (BGS) data (reports and maps);
- Analysis of hydrological maps and local data;

- Assessment of groundwater vulnerability and possible need for protection;
- Review of Envirocheck reports and any available historical maps;
- Obtain information on local abstractions and discharges from the Environment Agency;

This information was gathered and compiled in order to assess possible sources of contamination, pathways and key sensitive receptors in line with current legislation and guidance.

6.4 Relevant Policies and their Implications for Scoping

Table 6.1 Relevant Legislation, Policies and Guidance

Relevant Guidance	
The Water Framework Directive (200/60/EC)	Policy and Practice for the Protection of Groundwater
Water Resources Act 1991	Water Act 2003
Environment Protection Act 1990	Groundwater Regulations 1998
Environment Act 1995	UK Water Quality (Water Supply) Regulations 2000
Land Drainage Act 1991	Private Water Supply Regulations1992
Control of Pollution Act (as amended) 1974	Control of Pollution (oil storage) (England) Regulations 2001
Other Relevant Guidance	
PPG9 Biological and Geological Conservation	**Relevant Requirements**
9	Sites of regional and local biodiversity and geological interest, which include Regionally Important Geological Sites, Local Nature Reserves and Local Sites, have a fundamental role to play in meeting overall national biodiversity targets; contributing to the quality of life and the well-being of the community; and in supporting research and education. Criteria-based policies should be established in local development documents against which proposals for any development on, or affecting, such sites will be judged. These policies should be distinguished from those applied to nationally important sites.
12	Networks of natural habitats provide a valuable resource. They can link sites of biodiversity importance and provide routes or stepping stones for the migration, dispersal and genetic exchange of species in the wider environment. Local Authorities should aim to maintain networks by avoiding or repairing the fragmentation and isolation of natural habitats through policies in plans. Such networks should be protected from development, and, where possible, strengthened by or integrated within it. This may be done as part of a wider strategy for the protection and extension of open space and access routes such as canals and rivers, including those within urban areas.

16	Other species have been identified as requiring conservation action as species of principal importance for the conservation of biodiversity in England. Local Authorities should take measures to protect the habitats of these species from further decline through policies in local development documents. Planning Authorities should ensure that these species are protected from the adverse effects of development, where appropriate, by using planning conditions or obligations. Planning Authorities should refuse permission where harm to the species or their habitats would result unless the need for, and benefits of, the development clearly outweigh that harm.
PPG 25 Development and Flood Risk	A sequential approach should be taken to development in areas of flood risk that includes both the risk of flood and vulnerability of the proposed land use.
	A partnership approach should be taken with the Environment Agency over information and expertise.
	Flood risk should be considered alongside other spatial planning issues.
	Local Planning Authorities should ensure planning applications are supported by flood risk assessments, should minimize risk, give priority to sustainable urban drainage systems and ensure development is resilient and resistant to flood.
PPG1	General guide to the prevention of pollution.
PPG 5	Works in, near or liable to affect watercourses.
PPG 6	Working at Construction and demolition sites.
East Anglia Regional Planning Guidance 6 Policies	
Policy	**Relevant Requirements**
44	Development proposals should be resisted in floodplains and in areas at risk from flooding or coastal erosion. In identifying such areas, local planning authorities should have regard to the flood plain maps provided by the Environment Agency and to guidance published by Department of Environment, Transport and Regions (DETR). The flood return period and continuing advice on the potential impacts of climate change scenarios should also be considered.
52	To ensure that the issues relating to water supply are fully understood and debated, local Planning Authorities should hold regular discussions with the Environment Agency, water companies and conservation organizations when developing water-related policies and proposals. They should also work closely with the Environment Agency, water companies and conservation organizations on all other water-related issues.
53	In preparing development plans local planning authorities should take account of the Environment Agency's Regional Water Resource Strategy, Local Environment Agency Plans,

	Catchment Abstraction Management Strategies, groundwater vulnerability maps and groundwater source protection zone maps. The protection of water resources and provision for water abstraction should be given a high priority and rates of development should not exceed the capacities of existing or planned water supply systems, taking into account environmental constraints, to meet projected demand.
56	Local Authorities should work closely with the Environment Agency, the water industry and other interested parties to ensure that water supplies are brought up to European standards and that all beaches in East Anglia reach and maintain compliance with the European Union Bathing Water Directive.
Cambridgeshire and Peterborough Structure Plan	
Policy	**Relevant Requirements**
P6/3	If development is permitted in areas where flood protection is required, flood defense measures and design features must give sufficient protection to ensure that an unacceptable risk is not incurred, both locally and elsewhere.
P6/4	All new development will be expected to avoid exacerbating flood risk locally and elsewhere by utilizing water retention areas and other appropriate forms of Sustainable Drainage Systems (SuDS) for the disposal of surface water run-off.
P7/8	New development will be located and designed to minimize and where possible avoid air, land, and water pollution. Individual and cumulative impacts of development will be taken into account in the consideration of proposals and developers will be expected to take appropriate avoidance and mitigation measures. Local Planning Authorities should resist proposals that will adversely affect air quality in Air Quality Management Areas.
South Cambridgeshire Local Plan 2004	
Policy EN45	There is a general presumption against development, which will have an adverse environmental impact on the water environment, nature conservation, fisheries and water related recreation.

6.5 Past Land use

A review of Ordnance Survey, historical maps and an environmental search (Envirocheck Report, Appendix D1) were undertaken on the project area. This identified the former agricultural land use of the project area. A site of Special Scientific Interest (SSSI) exists adjacent to the southwest of the project area, which is marked as Hildersham Wood on the current OS maps. The River Granta flows some 1.3 km east of the proposed wind farm.

A site walkover was undertaken in August 2007. DR/EN11940/001/SW (Appendix D2) represents existing land uses, drainage patterns, flows and slope gradients within the project area as described in Table 6.2.

Table 6.2 Site Walkover details

	Description
Project Area Location	Ridge between Linton and Gt. Chesterford.
Current Use	Agricultural, varied crops.
SSSI's	Hildersham Wood is located adjacent to the southwest of the proposed wind farm.
Former Use	Agricultural.
Access roads	A bridleway is present to the east and there is a footpath running through the site.
Topography	The site is on sloping ground with a grade of approximately 8% to 12% depending on the location. The ground slopes towards the drainage ditch to the east of the proposed turbine locations as shown on Drawing DR/EN11940/001/SW (Appendix D2).
Services	No plans of services were observed.
Surrounding area	Linton town centre to the north east of the site. Grain store to northeast boundary of the site.
Vegetation	Stubble, ploughed and wheat.
Surface Water	Agricultural field drainage ditches are present and drain to the River Granta flowing some 1.3 km to the north-east of the site with and without water within the project area. The depths, widths and flow directions of the drainage ditches are represented on DR/EN11940/001/SW (Appendix D2). There was standing water on centre south of the site due to drainage channel blockage by vegetation.

6.6 Proposed Development

The proposed development plan showing access tracks, temporary compound, abstraction points, crane pads, cabling location plans as well as turbines design is yet to be adopted. It was considered that the final arrangement for the foundations would be confirmed once the turbine specification and manufacturer is determined. The land around the turbine would be flat as the foundation would be buried. Once construction is complete, the land could continue to be farmed right up to the turbine tower.

Road construction will be addressed in the Environmental Statement in liaison with the local Highways Authorities and the Highways Agency in consideration of the suitability of the access roads and the impact on the local road network. Vehicle access routes will be provided between the turbines for construction and maintenance, these will follow current tracks and field boundaries where possible. Existing on-site tracks would be utilised and upgraded where possible. Crane areas would also be constructed on arable areas. Roads will be suitable for carrying heavy trucks and cranes during the construction period. Access roads would be retained during operation in order to provide access for maintenance vehicles when required.

The Distribution Network Operator (DNO) will review the grid connection and propose a route during the course. Cables between the turbines would also be

required. A small excavator would be used to excavate the cable trenches to a depth of approximately 1.5m and a width of less than 1m.

A concrete foundation suitable for the model of turbine selected and the ground conditions will be designed after planning consent is granted, the design of the foundation will be adopted when the contract for the turbines is placed and the suitable investigation of the underlying geology is carried out.

6.7 Decommissioning

The wind farm will be built with specifications for an approximate 25-year lifetime. At the end of their working life the wind turbines will be removed and the ground surface will be reinstated to its former condition to allow the site to revert to its former agricultural use. It is envisaged that the buried cables will be disconnected, notified and left beneath the ground surface to prevent further ground disturbance, unless otherwise required by the Local Planning Authority. The potential impact during decommissioning is discussed and assessed within this Environmental Statement.

6.8 Baseline Geology

The county of Cambridgeshire is characterised by bands of solid geology, with chalk bounding the southern boundary to the extensive Oxford Clay formation in the north and west (Figure 6.1). The dominating consolidated clays and muds have characterised the flat topography of the area (Cambridgeshire and Peterborough's State of the Environment Report 1998, Chapter 11, Physical Background). The drift deposits are more variable across the county but are dominated by Boulder Clay with Peat, Silts and Clays making up the Fens.

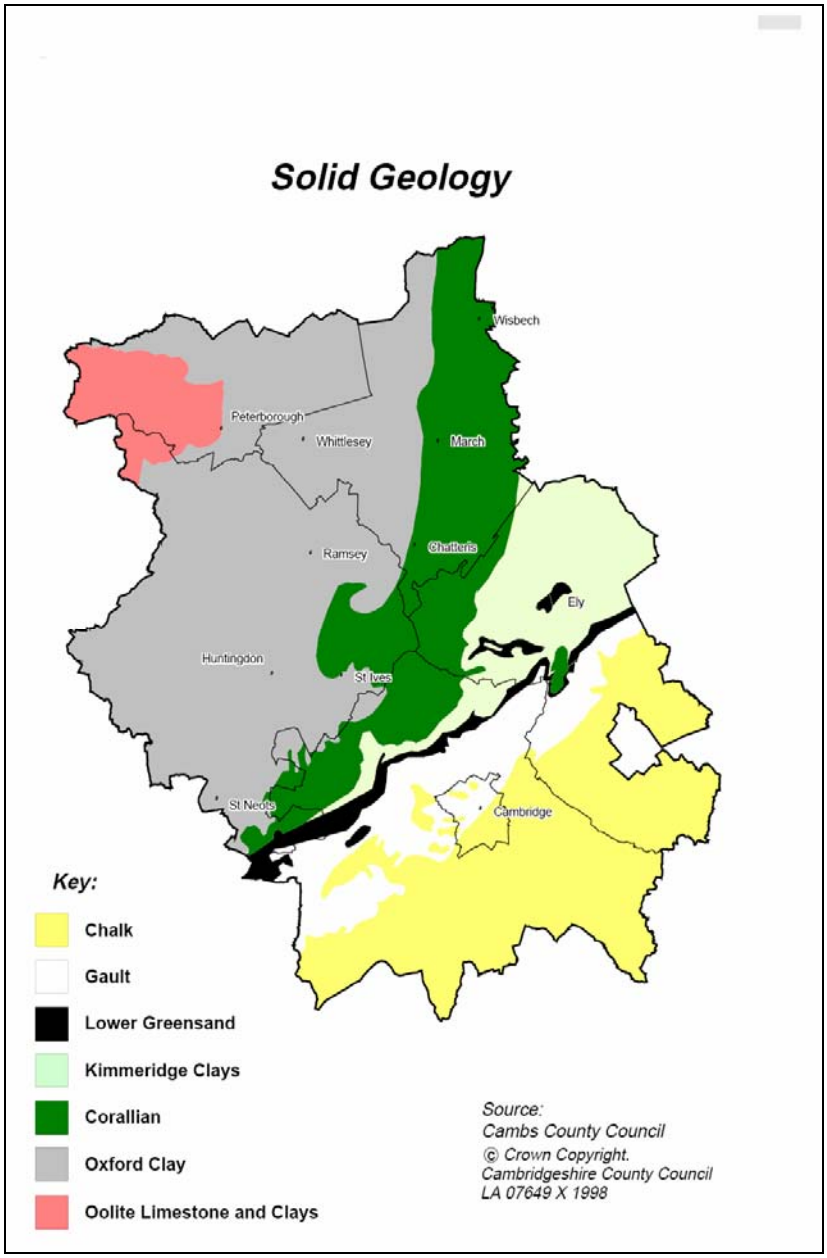

Figure 6.1 Solid Geology of Cambridgeshire

(Source: Cambridgeshire and Peterborough's State of the Environment Report 1998, Chapter 11, Physical Background)

	Lithology Description[1]	Engineering characteristics[2]
Drift Deposits		
Lowestoft Formation (LF)(Diamicton) to the south	Primarily stiff, bluish-grey clay when 'fresh'; orange-brown to brown where weathered; with varying amounts of chalk, flint, silt and sand. Derived mostly from Jurassic and Cretaceous strata; mainly silt with rare pebbles.	LF silt non cohesive: ranges from clay to clayed silt and silt. May be interlaminated with fine sands: trench is generally stable, can be used as fill and areas of unstable natural slopes unlikely. LF till cohesive soil: firm to stiff, fissure, grey or brown over consolidated sandy clay with chalk and flint clasts. Trench stability good but running sand from lenses is possible; suitable use as fill, unstable slopes are possible if saturated, loaded or undercut.
Lowestoft Formation Sand and gravel to the North West	The Lowestoft Formation forms an extensive sheet of chalky till, together with outwash sands and gravels, silts and clays. The till is characterized by its chalk and flint content. The carbonate content of the till matrix is about 30%, and tills within the underlying Happisburgh Formation have less than 20%. Thickness: Extremely variable. It is thickest in buried valleys where locally up to 60m may be present.	Medium-dense to dense, sand and gravel. May contain buried channels and lenses of clay, silt and peat; moderate trench stability. Less stable below water table; suitable for filling and areas of natural unstable slopes unlikely.
Solid Geology		
New Pit Chalk Formation to the north of the project area and Lewes Nodular Chalk Formation and Seaford Chalk Formation (Undifferentiated) to the south.	Principally blocky, white firm to moderately hard chalk with numerous marls or paired marl seams. Flint occurs sporadically in the upper part in the deeper basin areas of the Southern Province. In some localities flint, in seams, occurs to the base of the formation most notable over structural highs, towards the margins of the outcrop and within the Transitional Province. Thickness varies between 35 and 50m with some regions as little as 10 to 25m thick.	Very weak limestone with abundant flints. Properties dependent on weathering grade. Probably highly fractured or may be reduced to soft to firm soil in near surface zone. Possibility of Karstic weathering with solution pipes and more irregular areas; good trench stability dependent on weathering grade and fracture spacing.
Chalk Rock Member	White chalk subgroup dated Turonian to Santonian	Generally moderately weak limestone but properties are dependent on weathering grade.

[1] U2: http://www.bgs.ac.uk/geoindex/home.html
[2] Geology of the Saffron Walden District (BGS, 2003)

Table 6.3 Landmark Geology Report (LGR) and BGS Lithology Description

6.8.1 Geology on site

The research predicted the southern half of the site to be underlain by Boulder Clay with the remainder of the site underlain by Middle and Upper Chalk. Upper chalk will also be present beneath the Boulder Clay. An area of Glacial Sands and Gravels is noted near to the northern part of the site.

6.8.2 BGS Borehole data

Reference	Lithology Description	Depths
TL	Topsoil Chalk	0.00 – 0.35m 0.35 – 110m
TL 5162, 4460	Made ground Boulder Clay Middle Cretaceous Chalk	0.0 – 0.6m 0.6 – 3.0m 3.0 – 58.5m
TM 2402, 9452 Groundwater standing at 9.9m below well top	Top Soil Chalk	0.00 – 1.3m 1.3 - 46.6m

Table 6.4 Summary of conditions encountered at borehole locations

6.9 Geology - Potential impacts

In view of the location of the project area and the nature of the geology, which is of high vulnerability, it is anticipated that impact on local geology due to the use of vehicles and machinery, earthworks, access road, excavation and presence of quarrying excavation, is likely to be moderate/high unless appropriate mitigation measures are implemented, based on the following considerations:

- The wind turbines construction activities will be carried out in the geology of chalk/ Lowestoft formation, which are of high to intermediate permeability. (Figure 6.2 and Figure 6.3)

- Historical maps show no significant area of filled ground within the project area.

- The soil strength, bearing capacity, thickness and other physicochemical parameters of the soil beneath the wind turbines will be determined during a geotechnical survey prior to an appropriate foundation design.

- The surface of the chalk is prone to solution that may take the form of cylindrical pipes or more irregular areas. The voids may remain open or become filled with overlying deposits. If built upon, differential subsidence may result.

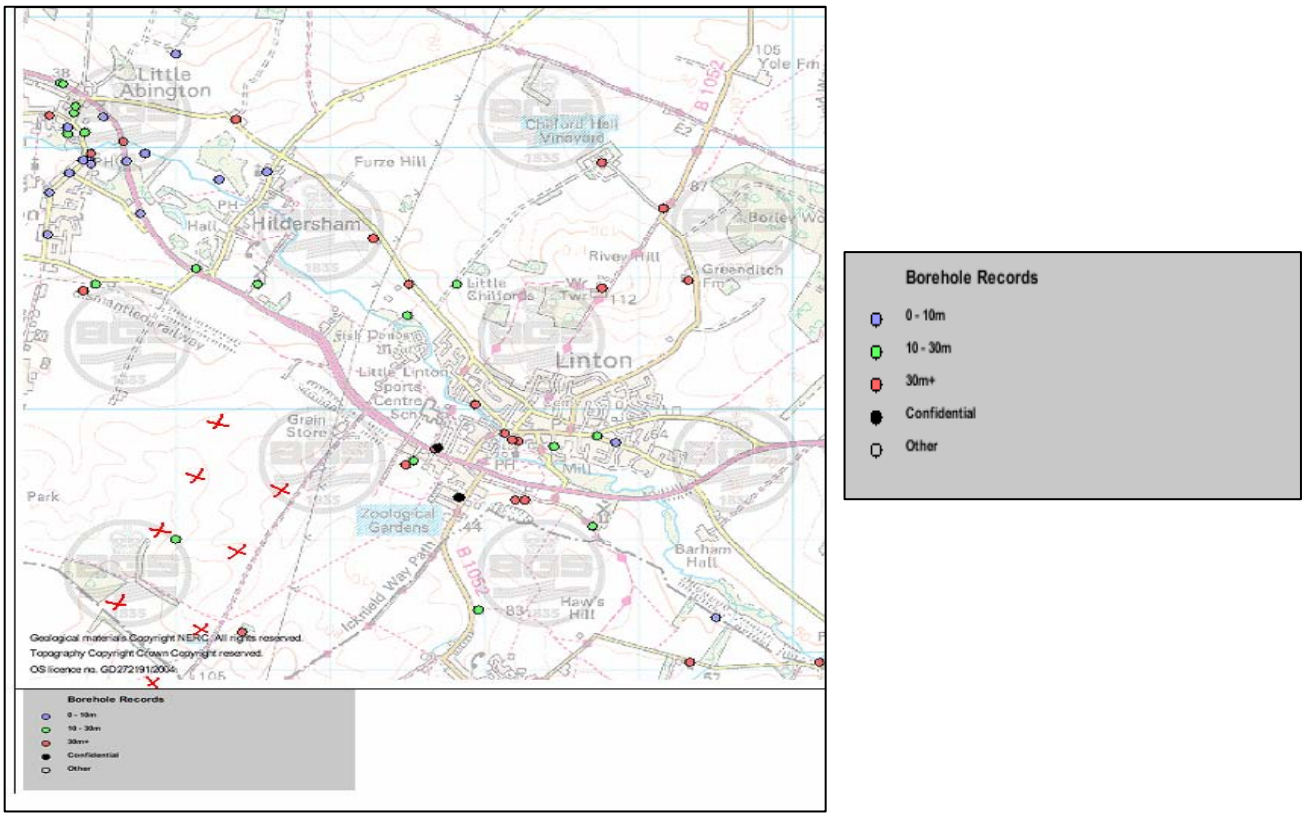

Figure 6.2 Borehole record located within 500 metres of the project area

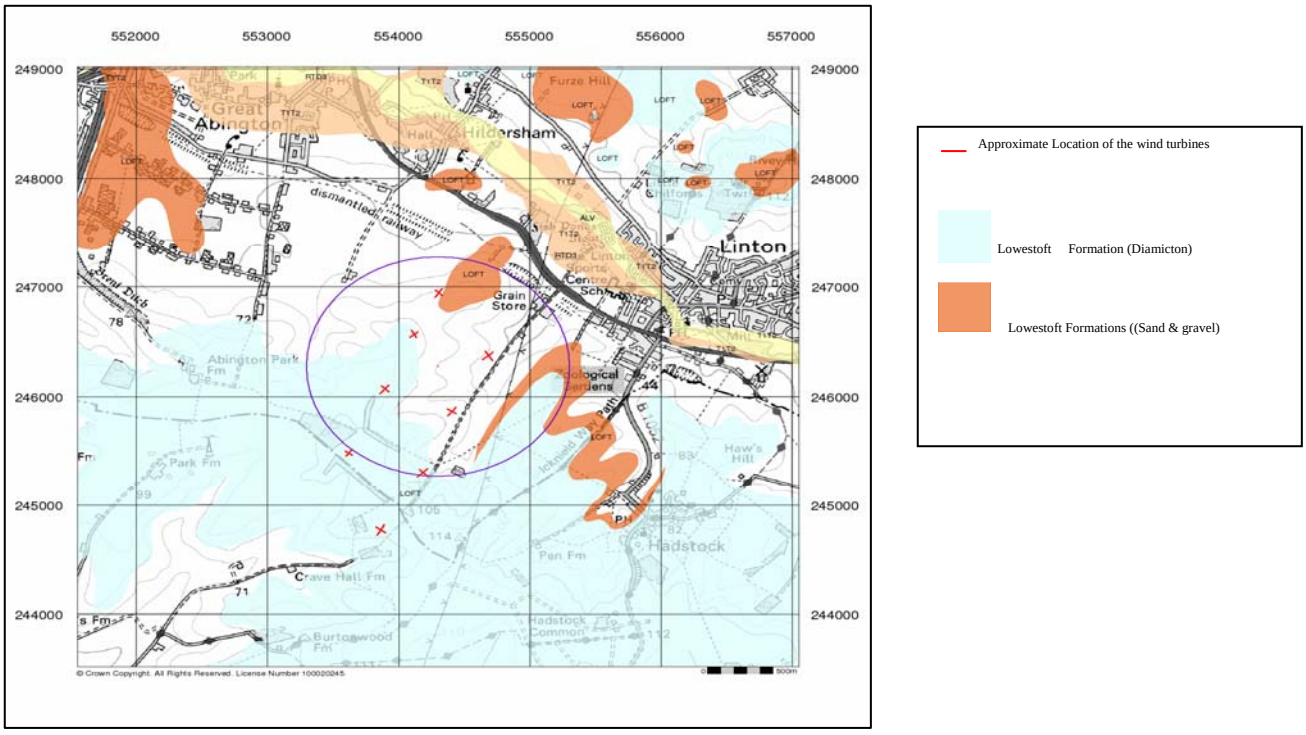

Figure 6.3 Superficial geology of the project area and approximate wind turbine locations

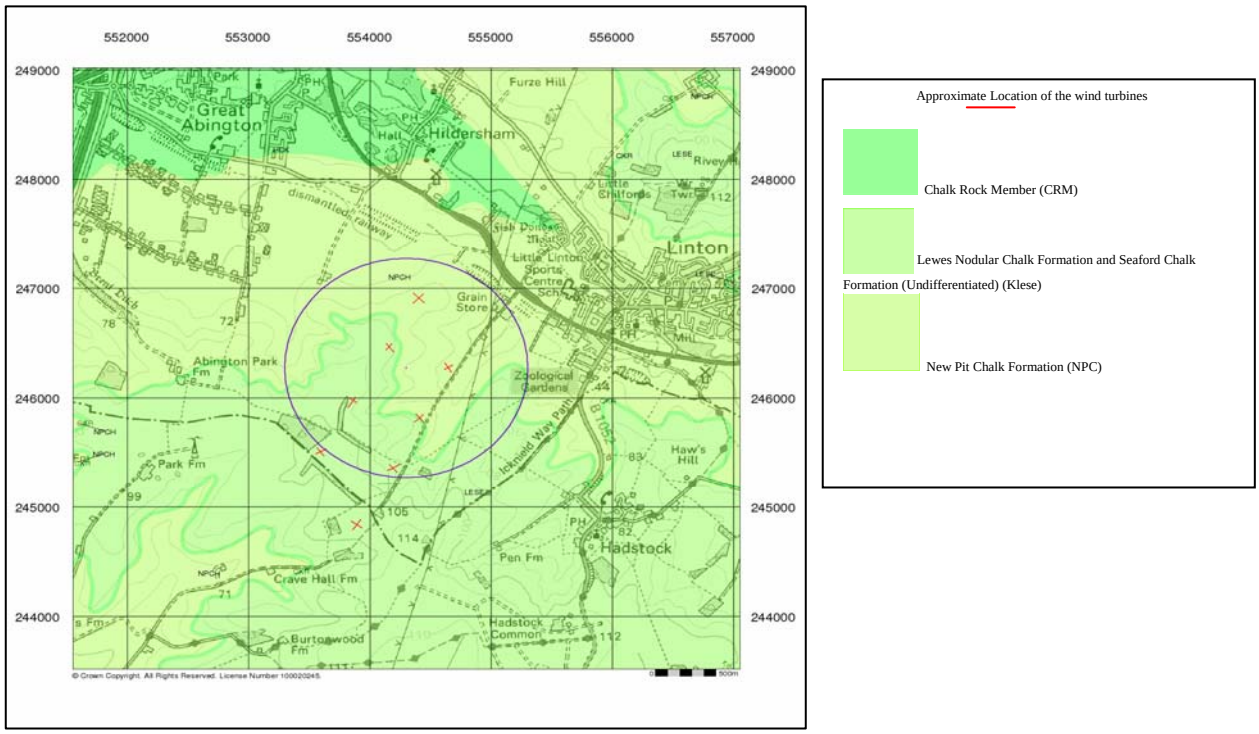

Figure 6.4 Solid geology of the project area and approximate wind turbine locations

6.10 Local Hydrogeology – Baseline Conditions

The project area levels are between 55maOD (metres above ordnance datum) and 100maOD. Hydrogeological maps indicate groundwater level at 20 to 30 metres AOD (i.e. 35 to 80 m below ground level). The chalk head is at 90 maOD (i.e. 10 to 35m below ground level). The Envirocheck report (Appendix D1) undertaken within 2 kilometres of the project area describes the site as over a major aquifer with the majority of the site underlain by soils of intermediate leaching potential. The southern and eastern half of the project area is underlain by soils of high leaching potential.

The search revealed no significant surface water within 1km of the project area. Most of the project area is located within Groundwater Source Protection Zone 3, with the north-west corner on a Source Protection Zone 2 and is not at risk from flooding.

The environmental search revealed that a water abstraction point (S Taylor /6/33/28/*G/0025/Well W) for agricultural and domestic end-use is located 736 metres from the centre of the proposed wind farm at grid reference 555000, 246500.

A consultation with the EA with regards to the Hydrology of the project area (EA Correspondence, Appendix D3) detailed the following information within 2km of the project area.

- There are a further fourteen licensed domestic water abstraction within 2 km of the project area.

- The site is in Flood Zone 1 defined as land outside the floodplain as shown on the EA's flood zone maps.

- The nearest water is the River Granta, 1.3 km to the north-east of the proposed wind farm. There are some drainage ditches to the south of the site running through the village of Little Chesterford to the River Granta or Cam. The sampling of this river at Bartlow -Fish Pond Moat Little Linton & Little Chesterford-Great Chesterford, enable its classification as grade C (EA, 2004-2006) meaning of fairly good quality. The EA defines river of quality C as a river that is a potable supply after advanced treatment or source of other abstractions, rivers with good cyprinid fisheries, natural ecosystems, or those corresponding to good cyprinid fisheries.

- Although the proposed site is not at risk of flooding, a flood risk assessment should be considered for particular severe events.

6.11 Hydrogeology - Potential Impact

Based on a qualitative assessment of the possible impacts on hydrological and hydrogeological resources resulting from the proposed wind farm, the sensitivity of the area is classified as high to medium and the magnitude is high to moderate as described in Table 6.5.

Table 6.5 Existing Geology, Hydrology and Hydrogeology of the project area; sensitivity and magnitude of the effect prior to application of mitigation measures.

Receptor	Description/ Source	Findings	Sensitivity	Comments
Geology	Geology	The desk study research predicted no drift geology on the majority of the site, with the southern part of the site underlain by Lowestoft Formation (Diamicton) and the north west corner underlain by Lowestoft Formation (Sands and Gravels) over Chalk expected at approximately 90maOD.	High /medium	The drift geology is either nonexistent or very shallow over chalk. Therefore, there is a pathway between potential surface contamination and the aquifer.
Ground-water	Hydro-geology of site and surroundings	The project area elevation is at between 55maOD and 100maOD. The slope gradient is from south to	High / Medium	Although there is no significant former contaminative industrial use of the site, the

Receptor	Description/ Source	Findings	Sensitivity	Comments
		north and northeast. The site overlies a major aquifer with the majority of the site underlain by soils of intermediate leaching potential with the eastern and southern part of the project area underlain by soils of high leaching potential.		geology of the site is vulnerable and the site is located within a groundwater source protection zone. Therefore, best practice will be adopted through out the construction, operation and decommissioning of the proposed wind farm to avoid groundwater pollution. Specifically, a Foundation Work Risk Assessment Report will be prepared and submitted to the Environment Agency.
	Groundwater	Groundwater is predicted to stand at approximately 20 to 30maOD. Or approximately 15 to 80 metres below ground level.		
	Groundwater Source Protection Zone	The project area is on a Major Aquifer, with no significant overlying impermeable stratigraphic layer. Most of the site is within Groundwater Source Protection Zone 3 (Total catchment area) with the northwestern part of the site within Source Protection Zone 2.		
	Water abstraction points	There are abstractions for agricultural and domestic end use within 2 km within the project area.		

Receptor	Description/ Source	Findings	Sensitivity	Comments
Surface water	Surface water or river catchments & site walkover	Approximately 1.3 km north-east of the northern most turbine is the River Granta which is classified as quality C* by the Environment Agency. A drainage ditch runs south-east to the River Granta through the village of Little Chesterford and through Linton Town Centre.	Medium/ Low	The site drainage system flows via drainage ditches to the River Granta flowing some 1.3km north east of the site (classified as C) and hence there is a pathway for site derived pollution to impact this river. The site lies within the catchment of the river Granta which is a groundwater fed river; therefore, pollution of groundwater, or alteration of the water table, may directly affect the water quality and flows and hydro morphology in the river. The site does not lie in a designated floodplain.
	Flooding	Risk from flooding is low.		
Others	Ground stability & Dissolution	Chalk outcrops may contain dissolution features that may cause future subsidence or collapse if built upon. Further, if structures are placed on or near to partially infilled dissolution features, these may be reactivated if changes in surface drainage patterns occur as a result of	High	Intrusive site investigation will be conducted to evaluate the likelihood of dissolution features.

Receptor	Description/ Source	Findings	Sensitivity	Comments
		construction.		
	Natural reserves	Site of Special Scientific Interest (SSSI){Hildersham Wood, N 74442.58}	High	The identified SSSI is adjacent to the south west of the site.

* Potable supply after advanced treatment, other abstractions, Good cyprinid fisheries, Natural ecosystems, or those corresponding to good cyprinid fisheries (Environment Agency).

Possible geological and hydrological impacts from wind farm developments during the construction**(C)**, operational **(O)** and decommissioning **(D)** phases are related to the main factors summarised in Table 6.6.

Table 6.6 Possible geological and hydrological impacts from wind farm developments during the construction(C), Operational/ Ongoing site maintenance (O) and decommissioning (D) phases

Receptor: Water	Activities	Impact	Phase	Project Specific Assessment
1-Surface Water Hydrology And Channel Morphology	Use of vehicles and machinery	Increase in surface runoff from soil compaction.	C, O & D	Highly permeable soil with potential compaction and erosion.
	Works	Change propriety of water course (flood risk, change on bed and bank stability due to erosion).	C	The slope at the site is approximately 8% - 12%. The risk of landslide and flooding is low.
2-Surface Water Quality	Earthworks	Increased sedimentation of water course.	C	Earthworks in chalk may result in generation of chalk fines that could result in sediment loading to the drainage channel east of the proposed turbine location.
	Site drainage	Rapid transfer of rainwater to water courses via drains.	O	Existing site drainage will be upgraded where appropriate.
3-Groundwater Hydrology	Earth works	Pollution from suspended materials. Disturbance of contaminated soils and subsequent pollution of water courses.	C	Chalk fines may result in significant suspended particulate loading to the drainage channel. Any seepage water from excavations will be appropriately contained and treated prior to discharge. A discharge consent may be needed from the Environment Agency.

Receptor: Water	Activities	Impact	Phase	Project Specific Assessment
	Material management	Pollution from spills or leaks of fuel, oil and construction materials /maintenance works/ material use in removal of turbines and associated infrastructures	C /O/D	Oil and fuel tanks will be stored in a designated area in accordance with the EA Pollution Prevention Guidelines, PPG2 Above Ground Oil Storage Tanks and in compliance with the Control of Pollution (oil Storage)(England) Regulations 2001. Measures will be taken to avoid chemical pollution on the site.
	Use of machinery	Sediment-loading of watercourses.	O	Minimal use of machinery during operation.
4- Groundwater hydrology	Earthworks and site drainage	Reduction in water table. Change to groundwater distribution and flow.	O	Due to the size of the wind farm project (8 turbines), the proposed construction of the turbines is likely to have a low impediment on groundwater flow if best practise is adopted throughout.
	Physical presence of turbine foundation	Possible minimal alteration of groundwater flow.	O	Due to the size of the wind farm project (8 turbines), the proposed construction of the turbines is likely to have a low impediment on groundwater flow if best practise is adopted throughout.
5- Groundwater quality	Earthworks	Disturbance of contaminated soil and subsequent groundwater pollution.	O & D	No significant contaminative former use of the site. However, given that the site is on a Major Aquifer, with limited overlying overburden, a Foundation Risk Assessment will be completed, and appropriate mitigation actions taken, depending on the selected piling or foundation methods.
	Material management	Pollution from spills or leaks of fuel, oil and building material.	C	Oil and fuel tanks will be stored in a designated area in accordance with the EA Pollution Prevention Guidelines, PPG2 Above Ground Oil Storage tanks and in compliance with the Control of Pollution (oil Storage)(England)

Receptor: Water	Activities	Impact	Phase	Project Specific Assessment
				Regulations 2001. Measures will be taken to avoid chemical pollution on the site.
Receptor: Land	**Activities**	**Impact**	**Phase**	**Project Specific Assessment**
1- Soils	Use of vehicles and machinery	Compaction, erosion and road runoff.	C, O and D	Chalk fines may result in significant suspended particulate loading to the drainage channel. Any seepage water from excavations will be appropriately contained and treated prior to discharge. A discharge consent may be needed from the Environment Agency.
	Earthworks	Further erosion of exposed soil. Removal or alteration of soil on site for access roads and foundation construction. Possible mobilisation of soil contaminants from quarrying.	C	Highly permeable soil with potential compaction and erosion. No significant contaminative former use of the site. However, given that the site is on a Major Aquifer, with limited overlying overburden, a Foundation Risk Assessment will be completed, and appropriate mitigation actions taken, depending on the selected piling or foundation methods.
	Access road	Possible soil erosion due to access roads being located on steep slopes.	O& D	Appropriate management measures will be adhered to reduce erosion of access road such as geotextile membrane, gravel or grass cover.
2- Geology	Excavation	Removal of rock/quarrying for construction materials on site like access roads & following site expansion.	C	Small excavator would be used to excavate the cable trenches to a depth of approximately 1.5m and a width of 1m therefore insignificant.
	Presence of quarrying excavation	Creation of quarrying may result in creation of possible slope instabilities of quarrying waste.	D	Effective stabilisation of altered landforms will be considered.

6.12 Geology and Hydrogeology Impact During Construction Phase

Potential sources of contamination to controlled water and land include;

- The inappropriate storage of hazardous material in the form of fuel/ oil and possible spillage in the ground, leaching of pesticides from agricultural field during soil disturbances.

- Mobilisation of suspended solids, particularly clays and chalks: During construction, there is a risk of the mobilisation of suspended solids, which may then enter watercourses located within the vicinity of the project area.

The risk of runoff or soil erosion depends on the physical features of the land and upon soil management. Actual events are determined by rainfall. Earthworks in chalk may result in generation of chalk fines that could result in sediment loading to the drainage channel east of the proposed turbine location. (DR/EN11940/001/SW, Appendix D2). Good management practices and drainage system design will help to minimise soil erosion and runoff of excavated soil during the construction phase. A small excavator for cable trenches will be used where possible to avoid significant soil disturbance and compaction.

6.13 Geology and Hydrology Impact During Operational Phase

The impact on hydrogeology is anticipated to be insignificant during wind farm operation with the assumption that it is maintained according to Pollution Prevention Guidelines.

6.14 Geology and Hydrology Impact During Decommissioning Phase

The turbines will be decommissioned and the ground surface reinstated to its former condition. The impacts during this phase are comparable to those considered during the construction phase. Therefore the same measures will be applied to avoid pollution of controlled water and disturbance of the geology.

6.15 Mitigation Measures

As a general measure, use of environmental best practice and sound construction methods will be applied during construction works.

6.15.1 Mitigation Measures during Construction Phase

Although there is no significant former contaminative industrial use of the site, the geology of the site is vulnerable and the site is located within a groundwater source protection zone. Furthermore, earthworks in chalk may result in generation of chalk fines that could result in sediment loading to the drainage channel east of the proposed turbine location (DR/EN11940/001/SW, Appendix D2). Good management practices and drainage system design will help to minimize soil erosion and runoff of excavated soil during the construction phase. Therefore, best practice will be adopted through out the construction, operation and decommissioning of the proposed wind farm to avoid groundwater pollution. Specifically, the following measures will be taken:

- A Foundation Work Risk Assessment Report will be prepared and submitted to the Environment Agency.

- A small excavator for cable trenches will be used where possible to avoid significant soil disturbance and compaction.

- Any seepage water from excavations will be appropriately contained and treated to remove suspended solids prior to discharge. A discharge consent may be needed from the Environment Agency.

- Silty water generated during construction activities will be collected and treated with a suitable method. This may involve the use of a settlement pond or tank, or a grassed area. It will not be pumped in to the surface water drainage system.

- Where possible water will be prevented from entering excavations by using cut-off ditches or walls.

- Exposed ground and soils stockpiles will be minimized. Where present, they will be seeded or covered and silt fences constructed to intercept small erosive channels.

- Construction activities will be scheduled to minimize the area and time soils would be exposed.

- Site road will be regularly brushed or scraped and kept free from dust and mud deposits.

- Within the construction compound a dedicated handling area will be constructed which would be isolated from surface water drainage systems, have an impermeable base and be bunded and secure. Where possible, re-fuelling of vehicles and machinery will be carried out in the dedicated handling area.

- Oils, fuels and lubricants will be stored at least 50 m from any boreholes or drainage ditches.

- Where possible, standing machinery would have drip trays placed underneath to prevent oil and fuel leaks resulting in pollution.

- A discharge consent may be needed from the Environment Agency.

During this phase, construction method statements will be produced and will incorporate best working practices and measures from the EA`s Pollution Prevention Guidelines. It will include

- A series of method statements relating to activities which have the potential to affect the groundwater resource, and outlining preventive measures.

- An incident plan outlining actions to be taken in the event of accidental chemical or foul water spills, or localized flooding. The plan will include the implementation of contingency planning provision, spill kits and staff and contractor training procedures.

During construction of the wind farm the construction project manager will ensure that the proposed mitigation measures are put in place and carried out in such a

manner as to minimize or prevent effects on groundwater or surface water bodies. Table 6.7 summarizes hazards and mitigation measures to be considered during the construction phase.

6.15.2 Mitigation Measures during Operation

The possible effects of the operational phase are similar to those associated with the construction phase, however these effects are less severe due to the reduced activity on site. Therefore, pollution prevention measures detailed in the construction mitigation section above will also be adhered to during the operational phase. The contingency plan will be updated to ensure that it is specific to the risk and appropriate procedures should a spillage occur during the operational phase.

Additional mitigation measures that should remain in place throughout the lifetime of the wind farm would include;

Chemical Pollution Including Foul Water: Chemical, fuels, lubricant and wastes will be stored on a bunded hard standing area. Sulphate resistant concrete will be used to prevent alkaline leaching from buried structures.

Flow Patterns on the Site (Including Drainage Patterns, Runoff Erosion and Localized Flooding): Following construction, there is likely to be negligible impact upon the drainage patterns, erosion and run off on the site from the proposed turbines construction, it is not considered necessary to implement any specific drainage solutions with respect to the site.

6.15.3 Mitigation Measures during Decommissioning

Mitigation measures for decommissioning activities are assumed to be similar to the proposed mitigation techniques for construction activities and are therefore not discussed separately.

Table 6.7 Potential Hazards and mitigation measures during the construction phase of the proposed wind farm development

Potential Hazards	Mitigation Measures
Chemical Pollution Including Foul Water (Oils, Fuels and Lubricants)	Oil and fuel tanks will be stored in a designated area in accordance with the EA pollution Prevention Guidelines, PPG2 Above Ground Oil Storage Tanks and in compliance with the Control of Pollution (Oil Storage) (England) Regulations 2001. The following measures will be taken to avoid chemical pollution on the site - A dedicated secure storage area for all chemicals including waste will be created within the temporary construction compound. Clear warning signs will be displayed at all access points. - Oils, fuels and lubricants will be stored in above ground storage tanks and containers that have been manufactured under a quality assurance system complying with relevant British Standards. - Storage tanks, containers and ancillary equipment will be

Potential Hazards	Mitigation Measures
	placed within oil and watertight secondary containment such as bund. The secondary containment system will provide storage of at least 110% of the tanks maximum capacity. - Secondary containments will be secured to avoid unauthorized access and vandalism. - Containers will be clearly labelled with the nature of contents and hazards they could pose. - Within the construction compound a dedicated handling area will be constructed which would be isolated from surface water drainage systems, have an impermeable base and be bunded and secured. - Where possible, re-fuelling of vehicles and machinery will be carried out in the dedicated handling area. - Oils, fuels and lubricants will be stored at least 50 m from any groundwater springs, boreholes, soakaways and drainage ditches. - Where possible, standing machinery would have drip trays placed underneath to prevent oil and fuel leaks resulting in pollution. - A contingency plan will be produced detailing site drainage and list of contacts in the event of a spillage in line with PPG21 Pollution Incident Response Planning. Spillages will be reported to the site manager immediately. A stock of absorbent material will be stored on the site to deal with spillages, and staff will be trained in their appropriate use - Training of staff on the correct use and storage of all oils and chemicals on the site
Foul Water	- Temporary sanitary facilities will be located within the temporary construction compound. Sewage effluent will be stored within integral foul water storage tanks and will be emptied on a regularly basis by licensed contractors.
Concrete Runoff	A designated concrete batching area will be constructed on site with bunds and an impermeable base in order to contain any washing. Any concrete batching, washing out and cleaning of concrete batching plant or ready mix lorries will be carried out in this specific area with wastewaters collected and disposed of off-site.
Compaction of Soils and Localised Flooding	The following measures will be taken on the site to avoid and minimize compaction; - The access track will be constructed of crushed aggregate appropriate to withstand the expected traffic loading. - Vehicles and machinery will be restricted to the access tracks. - Where appropriate, fencing will be used around the access tracks or working areas to prevent unintentional straying of construction machinery.
Runoff and Erosion	Increased surface water runoff, erosion of soils and sedimentation (e.g. increased sediment flow within the surface water run off from the construction site) could potentially occur as the result of construction activities on site. The following measures will be taken on site to minimize these effect; - Silty water generated during construction activities will be

Potential Hazards	Mitigation Measures
	collected and treated with a suitable method to be confirmed with the EA. This may involve the use of a settlement pond or tank, or a grassed area. It will not be pumped in to the surface water drainage system. - Where possible water will be prevented from entering excavations by using cut-off ditches or walls. - Exposed ground and soils stockpiles will be minimized. Where present, they will be seeded or covered and silt fences constructed to intercept small erosive channels. - Construction activities will be scheduled to minimize the area and time soils would be exposed. Site roads will be regularly brushed or scraped and kept free from dust and mud deposits.
Flow Patterns on The Site (Including Soil Interflow and Drainage Patterns)	Given the depth to groundwater beneath the site, there is likely to be insignificant impact upon groundwater flow, soil interflow and drainage patterns as a result of the proposed construction of the turbines. Notwithstanding the above the following measures will be taken to reduce localized interference on soil drainage patterns; - The base layer of the access tracks will be constructed from coarse material to maximum infiltration through the tracks, minimizing surface runoff and reducing the potential for erosion. - The effects of surface water control (i.e. dewatering of rainwater entering excavations during construction) are likely to be temporary and reversible. - To minimize disturbance, cables will be laid adjacent to access tracks as far as practicable: and, Drainage ditches will be regularly inspected for any sedimentation or blockages.
Groundwater Abstraction	If groundwater abstraction is required, the EA will be contacted for licensing and pollution prevention control procedures.
Geology	The geology is vulnerable because the chalk strata, which is of high permeability, is very shallow; therefore best practice will be adopted throughout the project to prevent groundwater pollution.
Potential Foundation	A foundation risk assessment report will be undertaken in conjunction with any geotechnical work prior to wind farm construction. Risk to controlled water and the existing geology will be taken into consideration during the foundation construction, operation and decommissioning of the wind farm.

14 References

Pages other than those containing the relevant topic references have been omitted.

West Coast Energy / The Cooperative, 2007, Report on extension to Coldham Windfarm Chapter Six: Ecological Assessment. Supporting document to planning application.

World Wildlife Fund, 2001, Wind farm development and nature conservation: A guidance document for nature conservation organisations and developers when consulting over wind farm proposals in England. Guideline document by WWF, EN, RSPB and BWEA.

Section 6: Geology and Hydrology

Existing Geological Maps (OS Explorer Lincolnshire Wolds South Sheet 273, 1:25000 & BGS borehole data)

Existing Hydrogeological Maps EA (Groundwater Vulnerability 1:100,000 Map Series Sheet 19 Lincolnshire)

Envirocheck Report

Environment Agency report for key potential impact of wind farm May 2002

Section 7: Landscape and Visual Character

East of England Regional Assembly “Placing Renewables in the East of England”, Final Report (Feb 2008)

East of England Plan 2001-2021

Local Authority Local Plan/LDF Documents

Braintree District Local Plan (adopted 2005)

Cambridge Local Plan (adopted 2006)

East Cambridgeshire District Local Plan (adopted 2000)

East Hertfordshire District Local Plan, Second Review (April 2007)

Forest Heath District Local Plan (adopted 2004)

North Hertfordshire District Local Plan (adopted 1996)

South Cambridgeshire District Local Plan (adopted 2004)

Replacement St. Edmundsbury Borough Local Plan 2016 (adopted 2006)

Uttlesford District Local Plan (adopted 2005)

County and District Landscape Character Assessments

Braintree, Brentwood, Chelmsford, Maldon and Uttlesford Landscape Character Assessment (2006)