

PARTNERSHIP FOR  
RENEWABLES

Sharpness Turbine  
Geotechnical Feasibility Report

# PARTNERSHIP FOR RENEWABLES

## Sharpness Turbine

### Geotechnical Feasibility Report

October 2011

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# Glossary of Terms

Term	Meaning / Definition
PfR	Partnership for Renewables
EA	Environment Agency
OS	Ordnance Survey
BGS	British Geological Survey
GI	Ground Investigation

# 1. Introduction

## 1.1 General

Atkins Ltd has been commissioned by Partnership for Renewables (PfR) to investigate the geo-environmental feasibility of constructing a single wind turbine at a defined location at Sharpness Dock (See Figure 1: Site Location Plan).

## 1.2 The Scheme

The scheme is located in Sharpness Dock adjacent to the Severn Estuary in South Gloucestershire, at approximate Ordnance Survey (OS) National Grid Reference SO668027. The scheme proposes the construction of one 1.5MW Wind Turbine located in an open field. The wind turbine is anticipated to have a hub height of around 80m with a rotor diameter of 82.5m. Such structures would be anticipated as having substantial associated foundations and an appreciation of the anticipated ground conditions and associated constraints is therefore required.

## 1.3 Objectives

The principal aim of this report is to identify, assess and summarise potential geotechnical risks, including the risks from land contamination and to controlled waters associated with the proposed turbine construction. Recommendations for further works and investigations resulting from this assessment are also included.

This report focuses on the ground related constraints for the proposed development. The significance of these will need to be assessed and considered in conjunction with wider issues that may impact on other aspects of the scheme in deciding how best to further develop the proposals.

## 2. Sources of Information & Desk Study

This section summarises the type of information and their sources which have been obtained and consulted as part of this desk study.

### 2.1 Topographical Information

The topography of the site was assessed through examination of current OS mapping and a recent aerial photograph of the site. Historical OS Maps, included as part of the Landmark Envirocheck Report [Ref: 01], were also utilised.

### 2.2 Geological Information

Geology of the site was determined from British Geological Survey (BGS) 1:50,000 Scale Solid and Drift Edition Map Sheet 234 Gloucester. In addition, the index of BGS Borehole records [Ref: 02] was consulted for availability of historical ground investigation records carried out within the area of interest. Four relevant boreholes within 500m and to the south east of the proposed Turbine location were obtained from the BGS as follows:

- SO60SE30;
- SO60SE32;
- SO60SE33; and
- SO60SE34.

It is understood that these boreholes were undertaken for British Waterways Board. The borehole records have been included within Appendix A2 of this report.

### 2.3 Environmental Information

Environmental Information pertaining to the site was obtained from Landmark Information Group Envirocheck Report [Ref: 01]. This information is summarised in Section 4 of this report. The full Envirocheck Report has been included within Appendix A3 of this report.

## 3. Field Studies

This section summarises the field studies which have been carried out specifically for this scheme.

### 3.1 Walkover Survey

A walkover survey was carried out by an Atkins Geotechnical Engineer and Environmental Consultant on 6<sup>th</sup> October 2011.

The site is accessed via a worn single track that is used as a public footpath, off Bridge Road and through a locked gate. The worn track is approximately 2.0m wide and has a clay/gravel surfacing with many pools of standing water. Access to the field, where the proposed turbine is to be located, is off the worn track and through an opening in the dense vegetation. The opening leads to a mowed area of grass that passes to the south of the site, perhaps providing vehicular access to a telecom mast that is located to the south of the site.

Site surfacing comprises grass with occasional scrub. Prior to undertaking the walkover weather conditions were dry. The ground underfoot was firm at the time of Atkins Walkover Survey and was slightly uneven with pockets of grass/reeds raised. This may indicate that during periods of wet weather or during the winter/spring, the area may be marshy. The land is generally flat, with a very gentle dip to the west towards the River Severn.

A metal fence and barbed wire provide the boundary between the site and the works to the east. Dense vegetation, including trees, shrubs and scrub is to the north and north west.

## 4. Site Description

This section summarises the information gathered as detailed in Sections 2 and 3 of this report.

### 4.1 Geography and Topography

The site is located in Sharpness Dock, Sharpness is located approximately 5km to the north west of Berkeley in Gloucestershire.

Site levels dip from approximately 25mAOD in the north to approximately 10mAOD in the south and west where the land meets the cliffs alongside the River Severn. The proposed turbine location is at approximately 15mAOD.

Sharpness Dock is surrounded by watercourses, including the River Severn approximately 100m to the west of the site, Gloucester and Sharpness Canal approximately 300m to the north east, Collett/Cullis quay approximately 500m to the south east and east and two basins to the north west and south west.

### 4.2 Geology

BGS 1:50,000 scale solid and drift edition mapping indicates the proposed site to be underlain by both superficial and solid deposits. This shows the mid section of the northern part of the site is shown to be underlain by Superficial Deposits comprising gravel deposits of the Kidderminster Station Member. These Superficial deposits and the remainder of the site are directly underlain by the Raglan Mudstone Formation, which is described as interbedded siltstone and mudstone.

The BGS boreholes to the south east of the site indicate ground conditions to comprise Made Ground resting on interbedded soft peat and very soft to soft silt/clay. These deposits are typical of alluvium deposits and may be associated with a historic watercourse in this location that is discussed further in Section 4.6. These deposits are not shown on the geological map. The alluvium deposits are underlain by stiff to very stiff becoming hard with depth silty clay resting on weak siltstone.

### 4.3 Hydrogeology

The Environment Agency website [Ref 09] identifies that the strata beneath the proposed site are designated a Secondary A Aquifer. Secondary A Aquifers include permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.

Overlying soils are shown to have an Intermediate (I1) vulnerability classification for Leaching Potential, which is defined as *“soils which can possibly transmit a wide range of pollutants”* relating to the downward passage of water and possible contaminants.

The site is not located within a Source Protection Zone (SPZ).

### 4.4 Hydrology

The nearest surface watercourse to the proposed turbine location is a canal basin, located approximately 150m to the north of the centre of the site that links the River Severn and the Gloucester and Sharpness Canal. Other surface watercourses/features have been described in 4.1

## 4.5 Environmental Setting

### 4.5.1 Water Abstractions

The Envirocheck Report identifies that there are two current, licensed surface water abstractions within 1km of the proposed turbine. The water abstraction licences are for the British Waterways Board required for the works site at British Gypsum Products.

### 4.5.2 Discharge Consents

There are six current consents to discharge to surface water within 1km of the proposed turbine location. There are three discharges to the River Severn relating to final/treated and trade effluent. There is one discharge to the Gloucester and Sharpness Canal relating to surface water and one discharge to a tributary of the Lower Severn relating to a pumping station.

### 4.5.3 Pollution Incidents

The Envirocheck Report identifies that there has been one pollution incidents to controlled waters within 1km of the proposed turbine. This incident was classified as Category 3 – minor incident relating to inert suspended solids as a result of a fire.

### 4.5.4 Waste

There are three licensed waste management facilities with 1km of the proposed turbine location. One is associated with composting; another is associated with metal recycling and the other with household, commercial and industrial transfer station.

The Envirocheck Report also identifies three registered waste management or disposal sites within 1km of the proposed turbine location. These are associated this recycling/reclamation and scrapyards.

## 4.6 Historical Development

The First Edition OS map dated 1881 (See Appendix A3 – Envirocheck Report) shows the proposed turbine location to lie within open fields. The current Bridge Road is shown, although unnamed, along with the unnamed track that forms part of the site, which passes to the north. The land to the north of the site is shown to be woodland and Sharpness Cottage is shown adjacent to the track to the north. The site is bounded to the south and east by open fields which are in turn bounded by railway lines and to the west by the River Severn. A row of houses are shown beyond the fields and railway to the south. There is a canal basin that provides access from the River Severn onto the Gloucester and Sharpness Canal to the north and a basin associated with the Sharpness Docks to the east of the site. A watercourse is shown running parallel to the basin to the east and south of the site, which passes through a sluice before discharging out to the River Severn. A railway embankment is shown to the south east of the site.

By 1902, the map shows allotments on the site; however by the 1921 mapping the allotments are no longer shown although they are shown to the south of the site. Land to the north east of the site was further developed by 1921, including the Sharpness Hotel and a recreation ground adjacent to the east and warehouses alongside the dock. The sluice to the south of the site is no longer shown and by the 1924 mapping it appears that the watercourse has been culverted extending from the basin to the east of the site passing by the residential properties to the south and discharging into the River Severn.

The 1954 mapping shows a series of buildings to the north-east of the site noted as a campsite in later editions of the mapping.

The 1972 mapping shows the current the recreation ground to be a football ground and the allotments are no longer shown. The campsite to the north east is shown as disused. The railway to the east of the site and west of Bridge Road is no longer shown although the embankment outline is still marked.

The 1978 mapping shows a timber yard located on the old railway embankment approximately 200m to the east of the centre of the site at its closest point. The timber yard was no longer present in this location on the 1993 mapping.

By 1994, the camp site and football ground are no longer shown. The land to the east of the site that was partly occupied by the football ground is now shown to be occupied by 'works'. A gas governor is located to the north east of the works, approximately 200m to the east of the centre of the site and an electricity substation in the east of the works building approximately 180m from the centre of the site.

The, maps between 1994 and the present time the site appears to have remained unchanged.

## 5. Ground Conditions

The ground conditions considered in this section are based on the findings of the BGS geological map and the BGS boreholes.

### 5.1 Made Ground

Given the site history of the proposed turbine location discussed in section 4.6 of this report, Made Ground is not anticipated to underlie the site.

BGS boreholes show Made Ground to be present approximately 300m to the south east of the proposed turbine location. This is likely to be associated with land improvement and development associated with the docks and railway. The Made Ground is recorded as excavated Keuper Marl, now known as Mercia Mudstone which is likely to have been engineered fill.

### 5.2 Alluvium

The BGS geological map does not indicate that Alluvial Deposits are present, however the BGS boreholes show these deposits to be present approximately 300m south east and 500m south of the site. These deposits may be quite localised and associated with the watercourse discussed in Section 4.6. However, it is possible that, given the proximity of the proposed turbine to the River Severn and the ground conditions recorded by the BGS boreholes, that Alluvial Deposits may be present at the site.

BGS boreholes indicate the Alluvial Deposits, if present, could comprise very soft to soft clay/silt with decayed root fibres, peaty silts, loose silty sand with lenses of peat and soft and compressed peat. These have been recorded between 2.5m and 9.2m thick and extending between 7.0m and 10.5m below ground level, although the composition and thicknesses of such deposits can vary significantly over short distances.

### 5.3 Kidderminster Station Member

The Kidderminster Station Member typically comprises gravel of quartzite with flints. These deposits are likely to underlie the Alluvial Deposits if they are present on the site.

BGS boreholes adjacent to the site do not record that these deposits were encountered.

### 5.4 Raglan Mudstone Formation

Superficial Deposits are shown to be underlain by the Raglan Mudstone Formation. These deposits typically comprise interbedded mudstones and siltstones.

BGS boreholes indicate the solid Raglan Mudstone is overlain by weathered strata which comprise very stiff to hard silty clay/clayey silt. The solid deposits comprise very weak to moderately weak clayey siltstone.

The BGS boreholes suggest that the weathered deposits are encountered between 7.4m and 10.5m below ground level. The solid deposits are indicated to be at depths greater than 8.9m below ground level.

### 5.5 Groundwater

Given the elevation of the site, together with proximity to the River Severn and the basins associated with the docks, groundwater is likely to be relatively shallow.

The BGS boreholes encountered groundwater at 1.6m, 2.8m and 9.0m below ground level during drilling no long term monitoring records are available for review.

## 6. Preliminary Assessment

### 6.1 Engineering Assessment

#### 6.1.1 Foundations

It is understood that a pad foundation is the Client's preferred foundation option for the proposed turbine where this solution is viable. As discussed in section 5, the geological map indicates the site may be underlain by superficial gravel deposits, in which case, subject to the results of the ground investigation and detailed design, a pad foundation may be possible. However, the historical borehole logs suggest that there is a possibility of soft organic clay/silt and peat deposits underlying the site. Should this be the case, then depending on the thickness and extent of such materials, it is possible that the foundations for the proposed turbine may need to be piled, or that additional mitigation or improvement measures will be required in order to allow a shallow foundation to be utilised.

#### 6.1.2 Access Road

An access track is required from Bridge Road to the proposed turbine. It is understood that the existing track extending from Bridge Road to the access gate, discussed in section 3, is suitable in this respect and will not require any work. The track extending from the access gate to the field will require widening and then a new track will be constructed across the field to a temporary compound and crane pad.

A ground investigation will be required to provide information on the ground conditions and the California Bearing Ratio (CBR) to determine the suitability of the formation for the pavement construction. Should the formation comprise gravel deposits a suitable CBR is likely to be achieved. However, should Alluvial Deposits be found to underlie the site, a low CBR is likely and further work may be required in the form of thicker construction or use of geotextiles to create a suitable formation for road construction.

#### 6.1.3 Crane Pad

The geological map indicates the site to be underlain by gravel deposits of the Kidderminster Station Member. However the historical boreholes suggest that the presence of Alluvial Deposits is a possibility. Based on this, two options may be considered to form the crane pad:

1. Should gravel deposits underlie the site then it is likely that a platform can be formed using a well compacted granular fill.
2. Should organic clay/silt or peat underlie the site then it is likely that greater excavation of the existing materials may be required to in conjunction with an increased construction thickness and/or geogrids to minimise the risk of differential settlement and to distribute the loading to the area more evenly.

The crane pad will need to be designed, taking into account the ground conditions and the loading from the crane and any other loading impacting the crane.

#### 6.1.4 Electrical Connection

It is understood that a new cable will be installed as part of the construction of the proposed turbine, providing an 11 kV underground connection linking the turbine to the control kiosk beyond the site boundary.

Information from the DNO indicates that a trench up to 1.0m deep and 0.75m wide will be required to install the cable and excavations up to 1.0m<sup>2</sup> in plan will also be required along every 250m length of cable to provide a joint hole.

In view of the anticipated ground conditions, forming excavations should be achievable using a machine excavator, with appropriate breaking out where existing surfacing or other obstructions

exist. Groundwater seepages may require management in terms of sump pumping to prevent ponding of water in the excavations.

As discussed in Section 4.6 it appears a culvert extends from the basin to the south east of the site passing to the south of the residential properties to the south of the site before discharging into the River Severn. This will need to be considered prior to the installation of the cable to establish the clearance between the ground level and/or pavement construction and top of culvert.

No buried service plan has been made available at the time of producing this document; therefore it is unclear whether the cable route options cross any existing buried services.

## 6.2 Geo-Environmental and Contamination Assessment

### 6.2.1 Introduction

Primary UK guidance for assessing and managing land contamination is presented in Contaminated Land Report (CLR) 11 [Ref.3]. CLR11 provides a technical framework for identifying and remediating contamination through the application of a risk management process. The question of whether risk is unacceptable in any particular case involves not only scientific and technical assessments, but also appropriate criteria by which to judge the risk and conclude exactly what risk would be unacceptable.

The Department for Environment, Food and Rural Affairs (Defra) Circular 01/2006 [Ref.4] presents categories of receptors to contamination and defines descriptions of significant harm to each type of receptor caused by contamination.

CLR11 requires development of a conceptual site model (CSM) to represent the characteristics of the Site and describe the relationship between potential sources of contamination (resulting from both on-and off-site historical and recent activities) and receptors to the potential contamination. As part of the CSM development, three elements, the **source** of contamination and associated contaminants, **receptors** (human beings, controlled waters (surface water/groundwater), fauna and flora of conservations designations/ecological systems and property which includes domestic animals and produce, livestock, crops, game, fish, buildings and infrastructure) to that contamination and the **pathways** between the two are identified and assessed. Where all three elements are present or are likely to be present, they are described as potential pollutant linkages (PPLs). The CSM is constructed based on the level of evidence to justify the 'reasonable possibility' and 'likelihood' of existence of PPLs should there be sufficient information.

The basic approach to land contamination risk assessment reported here follows the principles given in CLR11 and decisions regarding a site may be informed by:

- Tier 1 preliminary risk assessment, typically a desk study review and site walkover inspection to develop the preliminary CSM (PCSM) which will identify any PPLs;
- Tier 2 Generic Quantitative Risk Assessment (GQRA), typically a review of ground investigation and monitoring data, development of a CSM with an assessment of risk using precautionary, generic assessment criteria (GAC) relevant to the PPLs that represent minimal or tolerable risk; and
- Tier 3 detailed quantitative risk assessment.

This report presents a 'Tier 1 Preliminary Risk Assessment' in accordance with the CLR11 and has been based on the desk study information described in the preceding sections.

### 6.2.2 Sources

Historical maps show that the site has comprised bounded fields, with the exception of the period from 1902 to 1921, when it is thought to have been used as allotment gardens. These land uses are not considered to be potentially contaminative activities which could have given rise to contaminants in, on or under the land at the site. Therefore no on site sources of contamination have been identified.

The site is set within an area of mixed land use, with some current and historical industrial uses of the land within 200m to the east, south east and east such as a timber yard and unspecified works with a gas governor and electricity substation. Made Ground may be present associated with the railway embankment located within 250m to the south of the site. These industrial land uses are potentially contaminative and represent potential sources of contamination which could have migrated to the site in windblown, soil-derived dust, migrating groundwater and as migrating ground gas and vapours.

### 6.2.3 Receptors

Based on the current and proposed land use, the following potential receptors may be present:

- on-site human receptors: These include farm workers and the public who may access the site currently, construction workers involved in the proposed development and subsequent maintenance workers who are expected to visit site once the proposed wind turbine is operational;
- off-site human receptors: occupants of and visitors to Sharpness Cottage approximately 100m to the north of the site and construction/road maintenance workers;
- groundwater in the underlying aquifer;
- surface water courses adjacent and in close proximity to the site and listed in 4.1;
- livestock and crops on/adjacent to the site;
- on-site; buildings/infrastructure associated with the proposed wind turbine; and
- off-site property: buildings/infrastructure adjacent and in close proximity to the site including Sharpness Cottage.

### 6.2.4 Pathways

#### Human Receptors

Potential exposure pathways to the on-site human receptors identified include:

- dermal contact with and ingestion and inhalation of contaminants in soil, soil-derived dust and entrained surface water run-off and in shallow groundwater; and
- inhalation of vapours (volatile contaminants which volatilise from soil/groundwater to the surface)/ground gas.

Potential exposure pathways to the off-site human receptors identified include:

- dermal contact with and ingestion and inhalation of contaminants in windblown, soil-derived dust and in migrating shallow groundwater; and
- inhalation of migrating vapours/ground gas.

#### Controlled Waters Receptors

The potential pathways to groundwater and surface water include:

- leaching of contaminants from the unsaturated soil zone and vertical migration to groundwater; and
- discharge of contaminants entrained in surface water run-off, in migrating groundwater which discharges into the estuary and migration of contaminants along preferential pathways, for example service trenches and pipes.

#### Property Receptors

The potential pathways to livestock and crops include:

- dermal contact with and ingestion and inhalation of contaminants in windblown, soil-derived dust and in migrating shallow groundwater (livestock);
- inhalation of migrating vapours/ground gas (crops); and

- leaf contact with contaminants in windblown, soil-derived dust and root uptake of contaminants in migrating shallow groundwater

Potential pathways to buildings/infrastructure include:

- on-site: direct contact with contaminants in soil and shallow groundwater and migration and accumulation of vapours and ground gas in buildings and enclosed spaces: and
- off-site: direct contact with contaminants in migrating shallow groundwater and migration and accumulation of vapours and ground gas in buildings and enclosed spaces.

### 6.2.5 Preliminary Conceptual Site Model

A preliminary conceptual site model (PCSM) has been developed based on the sources, pathways and receptors described above. This is summarised in Table 6.1:

**Table 6.1 – Preliminary Conceptual Site Model**

SOURCE		PATHWAY	RECEPTOR
<b>Migration of contaminants to the site from the off-site potentially contaminative activities in windblown, soil-derived dust and groundwater and as migrating ground gas/vapours</b>		Dermal contact with and ingestion and inhalation of contaminants in soil, soil-derived dust and entrained surface water run-off and in shallow groundwater	On-site human receptors: Construction workers, future site visitors and maintenance workers, members of the public
		Inhalation of migrating vapours/ground gas.	Off-site human receptors: Occupants of and visitors to Sharpness Cottage, and construction/road maintenance workers
		Dermal contact with and ingestion and inhalation of contaminants in windblown, soil-derived dust and in migrating shallow groundwater (livestock)  Inhalation of migrating vapours/ground gas (crops)  Leaf contact with contaminants in windblown, soil-derived dust and root uptake of contaminants in migrating shallow groundwater (crops)	Livestock and crops on/adjacent to the site
		Discharge of contaminants entrained in surface water run-off, in migrating	Controlled waters – Secondary A aquifer underlying the site and surface water

SOURCE		PATHWAY	RECEPTOR
		groundwater which discharges into the estuary and migration of contaminants along preferential pathways, for example service trenches and pipes	courses adjacent and in close proximity to the site
		Leaching of contaminants from the unsaturated soil zone and vertical migration to groundwater	
		Direct contact with contaminants in soil and shallow groundwater	On-Site Property Receptors – buildings /infrastructure associated with the new wind turbine
		Migration and accumulation of vapours and ground gas in buildings and enclosed spaces	Off-Site Property Receptors - buildings/ infrastructure adjacent and in close proximity to the site including Sharpness Cottage

### 6.2.6 Summary

No potential on-site sources of contamination have been identified, although off-site sources have been identified and could have resulted in contaminants migrating to the site. However, given the type of off-site sources, distance and mechanisms of migration, the potential risks posed is considered low. The absence of contamination will be confirmed during the geotechnical ground investigation and if present, appropriate sampling to inform the risk assessment will be carried out.

## 7. Conclusions

This section aims to conclude the available information and engineering assessment of the anticipated ground conditions at the site and evaluate the geotechnical and geo-environmental risks which are associated with the proposed turbine location.

### 7.1 Geotechnical Risks

A geotechnical risk register is tabulated below. Based on the available information it is considered that none of the identified risks are significantly severe so as to restrict the proposed works beyond what would require normal engineering practice to resolve.

**Table 7.1 – Geotechnical Risk Register**

Probability (P)		Impact/ Consequence (I)		Risk Rating	Risk (P x I = R)	Response
Very Likely	5	Very High	5	Intolerable	17 to 25	Unacceptable
Probable	4	High	4	Intolerable	13 to 16	Unacceptable
Likely	3	Medium	3	Substantial	9 to 12	Early Attention
Unlikely	2	Low	2	Tolerable	5 to 8	Regular Attention
Negligible	1	Very Low	1	Trivial	1 to 4	Monitor

Hazard	Consequence	Risk Rating			Recommended Mitigation Measures	Revised Risk Rating		
		P	I	R		P	I	R
Unforeseen ground conditions	Re-design of foundations, access road and crane pad causing delay to programme	4	4	16	Designer to scope ground investigation in order to determine the ground conditions underlying the site and obtain information on the material properties to inform the design of the foundations and associated infrastructure.	2	4	8
Groundwater	Control of groundwater during piling	3	3	9	Ground investigation and monitoring to be undertaken to determine the depth of groundwater and seepage rates.	2	3	6
	Seepages during removal of soft soils requiring removal and management				Contractor to assess ground investigation information and manage groundwater seepages during excavations and during the installation of piles.			
Contamination	Requirement for risk assessment to assess potential risk posed to human health and environment from contaminated material and its suitability for off-site disposal	3	4	12	Designer to design appropriate ground investigation to enable identification and characterisation of contamination.	2	4	8
	Requirement for identification and implementation of mitigation measures to protect human health and the environment.				Designer to collect information on contamination to inform risk assessment and mitigation measures to protect human health and the environment and enable waste classification.			
	Associated delay to programme and increase in costs because of the actions described above							
Pad foundation	Poor ground conditions, resulting in delay to programme and increase in costs in order to re-design foundation.	4	4	16	Designer to scope ground investigation in order to determine the ground conditions underlying the site and to provide information on the material properties.  Designer to undertake detailed foundation design using the results of the above ground investigation.	2	4	8
Piling into rock	Refusal upon encountering rock	3	4	12	Designer to scope ground investigation in order to determine the nature, orientation and strength of rock.	2	4	8
	Deflection of pile at interface between soil and rock							

					Designer to consider piles that are suitable for installing into rock.			
Construction of crane pad	Differential settlement of the crane Instability of the crane	4	4	16	Designer to scope ground investigation to determine the ground conditions underlying the site and obtain information on material properties.  Designer/Specialist Contractor to design the crane pad suitable for ground conditions encountered and the imposed loads.	2	4	8
Installation of electrical connection	Insufficient clearance between ground level/pavement construction and culverts or any buried services	4	4	16	DNO and PFR to obtain information on location and depth of existing culvert and to review existing buried services plans.	3	4	12
Striking buried services	Damage to underground services	3	5	15	Obtain buried services plan prior to any intrusive works. Apply permit to dig method of working to ensure the area has been cleared of buried services prior to construction.	2	5	10

## 8. Recommendations

### 8.1 Geotechnical Issues

It is recommended that a ground investigation be undertaken to determine the ground conditions underlying the site and to provide information on the nature, characteristics and properties of the soils and underlying rock. The results of the investigation will be used to facilitate the design of the proposed turbine foundation, access track and crane pad.

### 8.2 Potential Contamination Issues

It is recommended that environmental samples are collected from exploratory holes formed at the site as part of any intrusive ground investigation works so that laboratory analysis can be undertaken to enable confirmation that the material present at the site does not pose a risk to human health or the environment.

## 9. References

1. Landmark Group Envirocheck Report Reference 36168653\_1\_1
2. British Geological Survey (BGS) GeoIndex online borehole record facility [www.bgs.ac.uk](http://www.bgs.ac.uk)
3. Contaminated Land Report (CLR) 11 *Model Procedures for the Management of Land Contamination*
4. The Department for Environment, Food and Rural Affairs (DEFRA) Circular 01/2006

