In Confidence

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

A REVIEW OF THE HYDROGEOLOGY ELEMENT OF THE MELLOCK HILL WIND FARM ENVIRONMENTAL STATEMENT

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Section 1

Location of the Mellock Hill site

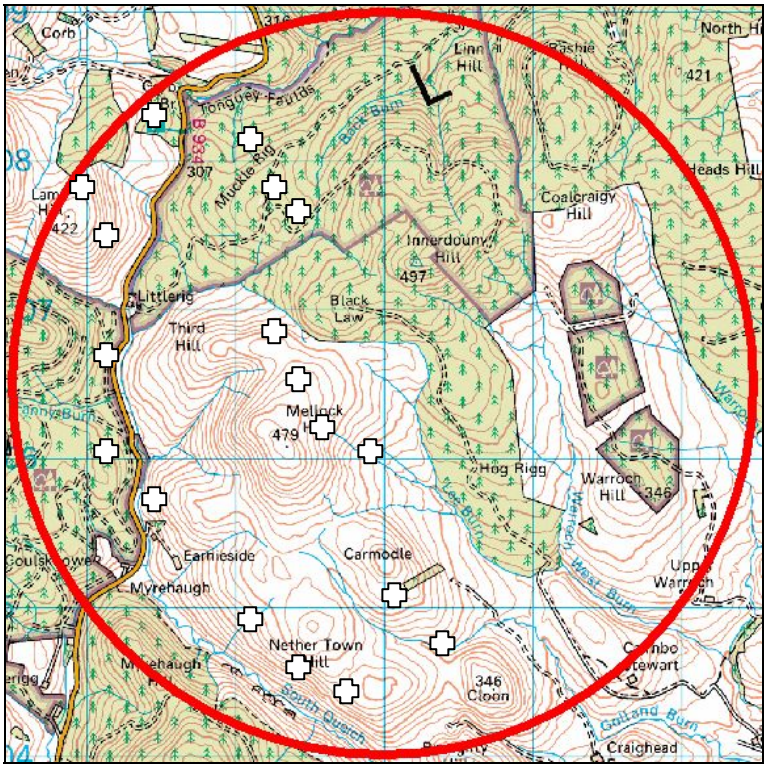


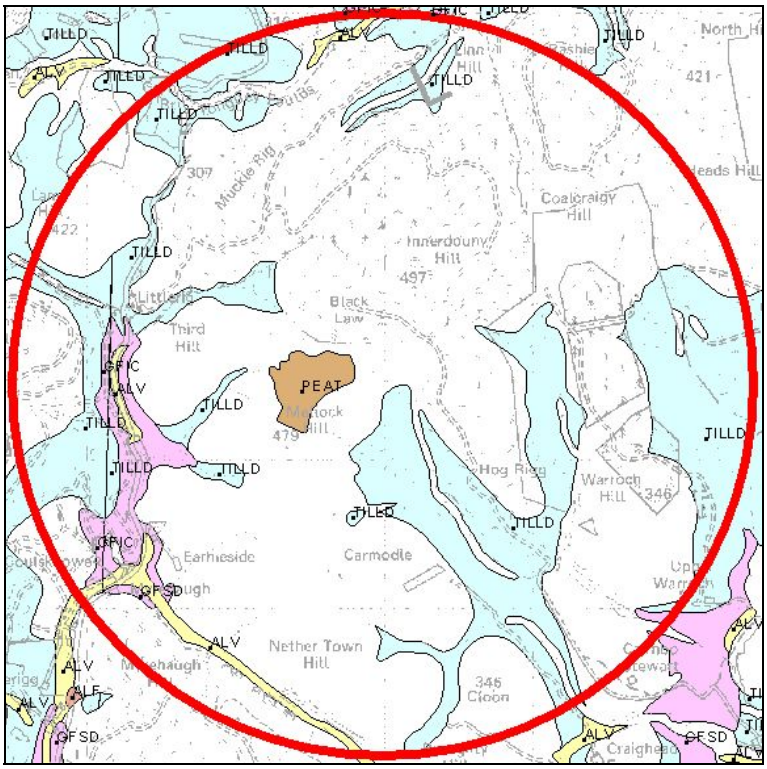
Figure 1: Location of the Mellock Hill site

The site is located approximately 10 km north-west of Kinross in the Ochil Hills

Geology

Superficial Deposits

These include fairly recent geological deposits, such as river sands and gravels, or glacial deposits, which lie on the bedrock in many areas (an alternative term for Superficial deposits is 'Drift Deposits')



Scale: 1:50000 (1cm = 500m)

Key to Superficial deposits:

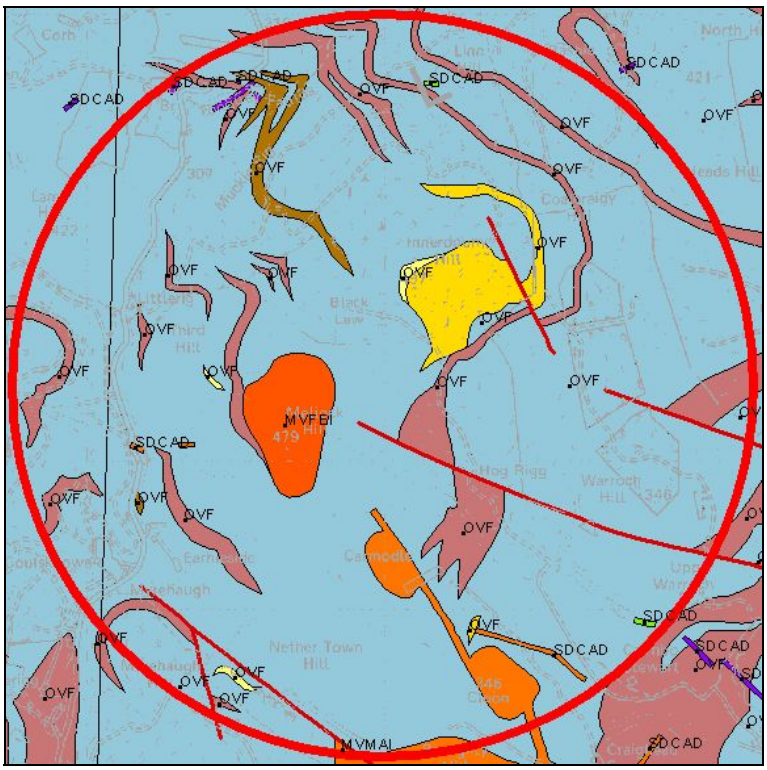
Map colour	Computer Code	Rock name	Rock type
	ALF	ALLUVIAL FAN DEPOSITS	SAND AND GRAVEL
	ALV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	ALV	ALLUVIUM	GRAVEL, SAND AND SILT
	PEAT	PEAT	PEAT
	GFIC	GLACIOFLUVIAL ICE-CONTACT DEPOSITS	GRAVEL, SAND AND SILT
	GFIC	GLACIOFLUVIAL ICE-CONTACT DEPOSITS	SAND AND GRAVEL
	GFSD	GLACIOFLUVIAL SHEET DEPOSITS	SAND AND GRAVEL
	TILLD	TILL, DEVENSIAN	DIAMICTON

Figure 2: Superficial deposits

Much of the lower and middle hill slopes are underlain by patchy glacial till (Figure 2) that is expected to thicken at lower elevations. The deposit is a predominantly clayey, stony deposit with occasional coarser grained sand and gravel horizons. The main proposed area for turbine installation is underlain by very thin superficial deposits with bedrock either at or very close to surface. Alluvium (typically comprising poorly consolidated sands, gravels, silts and clays) is present to the north

of the site area and also to the south where it is associated with the South Queich. A small area of glaciofluvial deposits, comprising sand and gravels with clays and silts, is also mapped to the west of the site. A small area of peat >1 m in thickness lies on the north east of Mellock Hill, but many other areas are underlain by thinner deposits.

Bedrock



Scale: 1:50000 (1cm = 500m)

Fault

Coal, ironstone or other mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	OVF	OCHIL VOLCANIC FORMATION	BASALTIC ANDESITE
	OVF	OCHIL VOLCANIC FORMATION	PYROXENE-ANDESITE
	OVF	OCHIL VOLCANIC FORMATION	ANDESITIC TUFF
	OVF	OCHIL VOLCANIC FORMATION	CONGLOMERATE
	OVF	OCHIL VOLCANIC FORMATION	RHYOLITE
	OVF	OCHIL VOLCANIC FORMATION	TRACHYTE GROUP
	MVFEI	MIDLAND VALLEY SILURO-DEVONIAN FELSIC INTRUSION SUITE	FELSITE
	MVMAI	MIDLAND VALLEY SILURO-DEVONIAN MAFIC INTRUSION SUITE	MICROGRANODIORITE, PORPHYRITIC
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	DIORITE
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	DOLERITE
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	FELSITE
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	MICRODIORITE, PORPHYRITIC

Figure 3: Bedrock geology

Lower Devonian basalt-andesite rocks of the Ochil Volcanic Formation underlie the whole site (Figure 3). These rocks have been intruded by other igneous rocks in the form of dykes and sills. The volcanics are fine-grained, fractured rocks, the upper few metres of which at rockhead are normally highly fractured as a result of glacial activity and weathering processes.

2 Hydrogeology

Superficial deposits

We have no detailed data on the hydrogeology of the Mellock Hill project area, but an assessment of the groundwater conditions can be gained from experience elsewhere where the geology is similar.

Shallow groundwater may be present in relatively small quantities within any sandy, gravelly beds interbedded within the till deposits that drape the valley sides. These water-bearing deposits may be common in the area, particularly on the lower slopes of the valleys where they can form useful, but vulnerable, domestic supplies. However, the main body of till itself can also have a significant permeability owing to the sandy nature of the material and the presence of fissures and fractures. These result in complex, shallow, groundwater flow paths that are normally localised in extent. The latter flows may be dominated by the presence of higher-permeability beds of sand and gravel which may occur sporadically. Groundwater also occurs in the alluvium and will eventually flow into the stream, contributing to river baseflow.

Areas of peat and mire can, in places, be supplied with groundwater from springs emanating in upland tills.

Bedrock

The upper weathered zone of the Ochil Volcanic Formation is the principal layer where groundwater is present. Rainwater infiltrates from the surface to enter the relatively permeable thin fractured zone which lies above fresh rock. Many shallow wells are dug into this layer to intercept the water table. Water can also enter any deeper fractures and fault lines that may be present. Groundwater then moves down slope to appear at springs.

Section 2: The Environmental Statement review

The Environmental Statement (ES) has been produced by West Coast Energy Ltd and is dated September 2004.

The proposal is for the construction of up to 24 turbines at near Mellock Hill, 8 km west of Kinross (centred at approximately NO 030 065).

Chapter 10: Hydrogeology

Geology

10.4.11 provides a geological description of the solid geology and 10.4.13 provides a description of the superficial geology.

Overall, an accurate summary.

Hydrogeology

10.4.20 provides a description of the hydrogeological conditions across the site. Recognition of the relatively low amount of groundwater held in storage in the bedrock is made but that groundwater may occur where the rock is fractured or weathered.

No mention is made of the potentially significant shallow groundwater present in the coarser grained, sands and gravels within the till and in the alluvium. This could be very important when considering the potential impact on surface waters as the water in these deposits, particularly the Alluvium, may provide a significant contribution to baseflow in nearby surface waters and supply private properties. Many boreholes provide water supplies in other parts of Scotland from similar superficial deposits.

No Mention is made of any potential weathered zone at rockhead where, if present, may have enhanced permeability. Abstraction of groundwater can also be made from water-bearing fractures over 60 metres below surface in the weathered or fractured bedrock.

Groundwater vulnerability

No mention is made of groundwater vulnerability.

SEPA's latest vulnerability maps, produced by the BGS, indicate that fractured bedrock with thin or no sandy till cover is highly vulnerable to pollution. However, these maps are not available to consultants yet. The fractured nature of the aquifer can lead to rapid flow of water and the aquifer is therefore vulnerable to contamination from the surface.

Receptors

Private water supplies:

Figure 10.1 shows the locations of the identified local water supplies. Except for Golland Farm these are all outside the site area. No further details on the nature of these supplies (i.e. whether groundwater or surface water) are provided.

The locations of the abstraction points indicated on figure 10.1 suggest that the private water supplies at Golland Farm, Earnieside Farm and Littlerig are the only private water supplies that could be affected by the wind farm development. However discussions with local residents indicate that there are a number of properties with private water supplies that are not identified in the ES such as Braughty Farm, Craighead Farm and Carnbo Stewart.

Figure 10.1 should be clearer and more detailed with regard to private water supplies. The latter should all be labelled and the actual source of the water specified. Section 10.8.19 refers to the Golland Farm supply, but does not give sufficient details for the source, particularly location. A Table is required showing all sources and their exact locations.

It is important to determine the location and nature of all private water supplies in the area. It is likely that many of the properties are supplied either from shallow groundwater in the sand and gravel horizons that occur within the till or from the bedrock as where it is locally fractured and weathered it has the potential to provide significant quantities of water. Due to the fractured nature of the bedrock, rapid flow can occur and sources some distance away may be affected by the proposed development, although it is unlikely that any deep abstraction boreholes located more than 2 km from the margins of the development would be affected.

The mitigation measures and predicted impacts outlined in Section 10 regarding the impact on groundwater of concrete pouring are generally correct. However, these should refer to receptors such as the Golland Farm spring.

Surface water:

10.4.19 considers the existing hydrological regime of the site area. Table 10.3 considers the potential impacts on the hydrology and finds that loss of surface water bodies is a major potential impact and that contamination of watercourses by concrete on placement, fuels, oils or suspended solids is of major to moderate significance. It also considers that changes in runoff patterns and flooding are of a moderate to slight potential significance.

The use of surface waters for water supply is not mentioned.

Discussions with local residents has indicated that the majority of farms in the area rely on surface water for their livestock. The BGS considers that groundwater baseflow to streams may be significant. Therefore, the construction of tracks and pits some distance from steams may have a temporary effect on the quality of water in them and also the private water supplies of any properties that use surface water for

water supply. This is unlikely to be significant, but the role of shallow groundwater flow in bedrock and drift deposits as baseflow to surface streams should be recognised.

Groundwater-dependent ecosystems

Chapter 8 considers the impacts of the proposed development on the sites ecology.

A table on page 184 considers the potential effects on the ecology and states that the effect of water pollution (loss of sensitive habitat and salmonids) is considered of moderate significance during construction, operation and decommissioning.

10.4.5 states that, although there are no designated areas within the site area, the Glen Queich is an SSSI due to its ecology.

The BGS considers that there may be a minor, localised, impact on surface waters and groundwater dependent ecosystems during construction, from the discharge of sediment into nearby water bodies from surface water run off during construction, operation and decommissioning but that this is considered to be low risk. This could, potentially, affect the water quality of the South Queich, which is located just to the south of the site.

Monitoring

No mention of a groundwater monitoring programme is included in this report.

The BGS considers that routine quality inspections of sensitive environmental features within the site and the vicinity should be carried out along with monitoring of all private water supply sources that could be affected by the proposed development works.

Conclusions

- A survey of private water supplies should be carried out to identify the type and locations of all sources of water supply in the vicinity of the site and to highlight any supplies that are considered to be at risk from the proposed development. From discussions with local residents there are a number of properties that rely on private water supplies that have not been identified by the ES.
- Shallow groundwater in the sandy till and weathered bedrock zone is likely to be providing significant amounts of groundwater as baseflow to streams and the springs and a number of shallow wells and boreholes exploit these groundwater resources. Shallow groundwater also supports areas of mire and wet heath.
- Whilst the BGS considers the overall risk to groundwater receptors as low, there may be local impacts on shallow groundwater with temporary reductions in water quality and effects on groundwater dependant ecosystems.
- Routine quality inspections of sensitive environmental features within the vicinity of the site should be carried out with monitoring of all private water supplies that could be affected by the proposed development works both pre-during and post construction.
- The Glen Queich is designated an SSSI for ecological reasons and is located close to the south of the proposed site area. It is possible that the water quality in the South Queich catchment could be effected by the proposed wind farm development.