



**British
Geological Survey**
NATURAL ENVIRONMENT RESEARCH COUNCIL

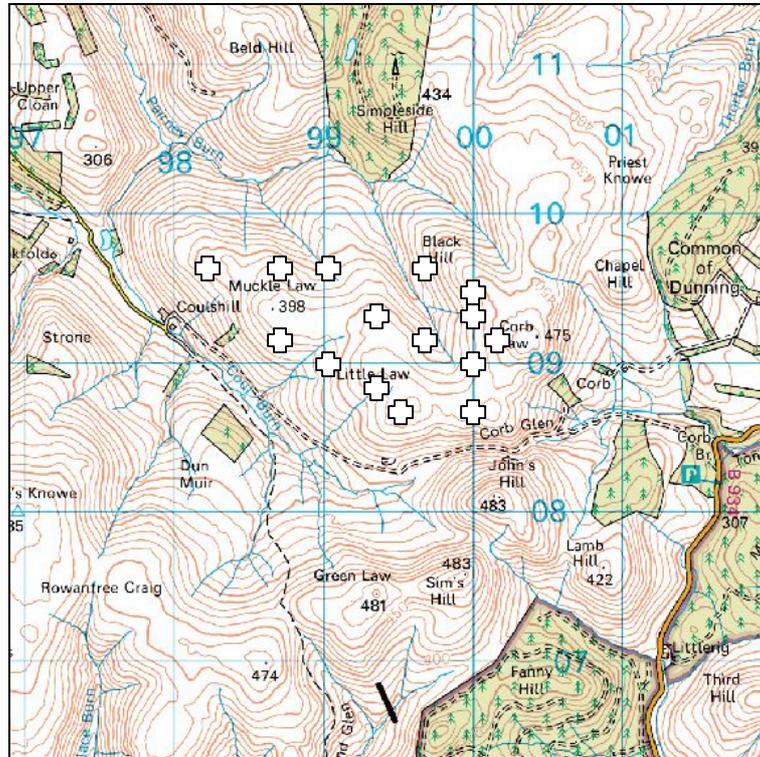
**A REVIEW OF THE HYDROGEOLOGY ELEMENT OF THE
LITTLE LAW WIND FARM ENVIRONMENTAL STATEMENT**

November 2004

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Section 1

Location of the Little Law site



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

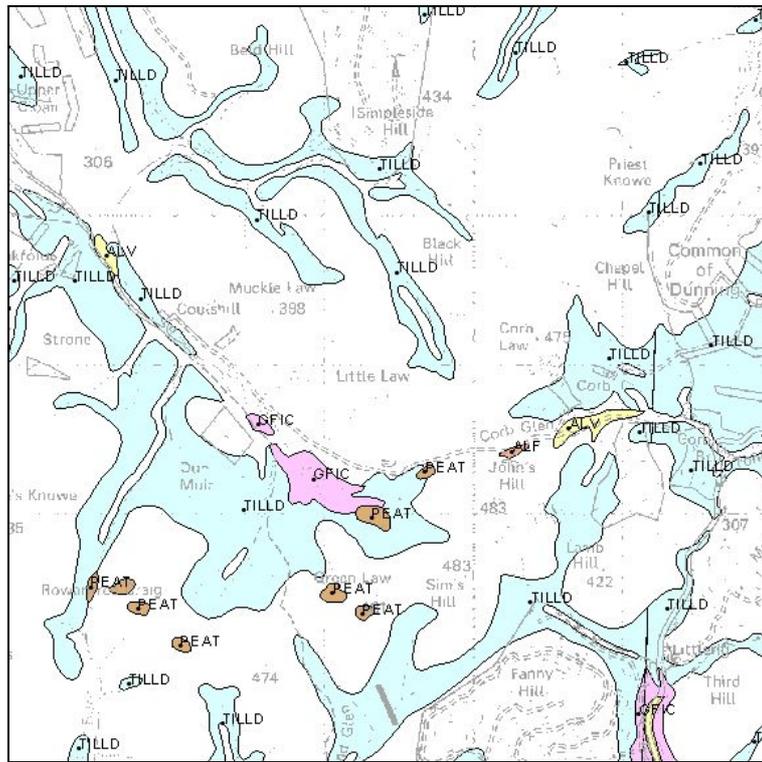
☐ Approximate area of turbines

Figure 1: Location of the Little Law site

Geology

Superficial Deposits

Much of the upper parts of the hillside are underlain by thin, patchy glacial till (Figure 2). This is a predominantly clayey, stony deposit with occasional coarser grained sand and gravel horizons. The main proposed area for turbine installation is underlain by superficial deposits generally less than 1 m thick, with bedrock either at or very close to surface. Minor patches of alluvium (typically comprising poorly consolidated sands, gravels, silts and clays) are mapped in the south-east of the area, associated with the Water of May and the Coul Burn. A small area of Glaciofluvial Deposits (comprising sand and gravels with clays and silts) and a few areas of peat are mapped near the floor of the Coul Burn catchment of the site, but these are on the opposite side of the valley to the proposed development.



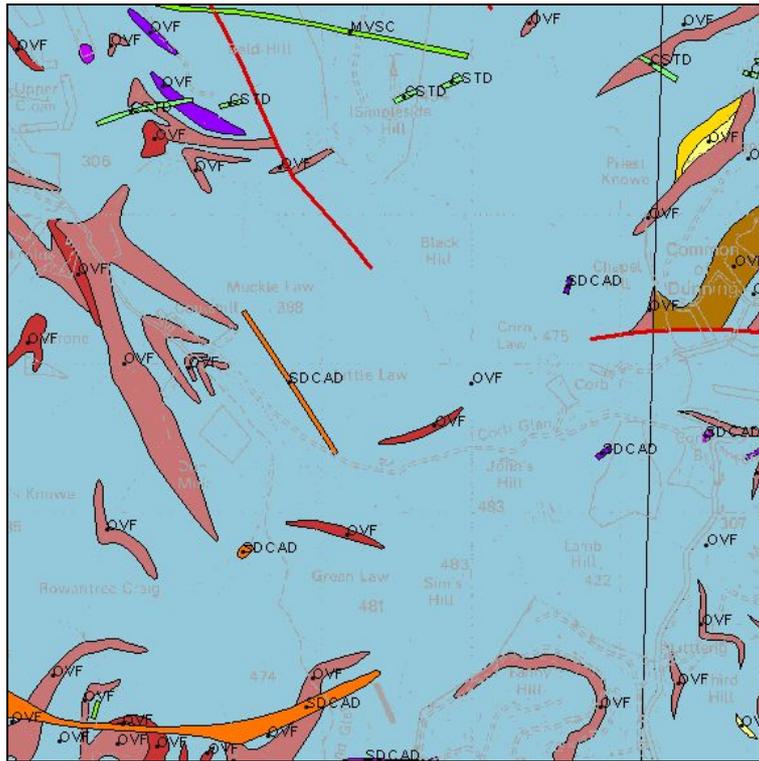
Scale: 1:50000 (1cm = 500m)

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	SAND AND GRAVEL
	GFSD	GLACIOFLUVIAL SHEET DEPOSITS	SAND AND GRAVEL
	TILLD	TILL, DEVENSIAN	DIAMICTON

Figure 2: Superficial deposits

Bedrock

Lower Devonian Basaltic-Andesite rocks of the Ochil Volcanic Formation underlie the whole site (Figure 3) with igneous intrusions. These are hard, fine-grained, fractured rocks formed as lava from volcanic outpourings. The upper few metres of the rock are normally more fractured and weathered than deeper, fresher, rock as a result of glacial activity and weathering processes.



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

Map colour	Computer Code	Rock name	Rock type
	CSTD	CENTRAL SCOTLAND LATE CARBONIFEROUS THOLEIITIC DYKE SWARM	QUARTZ-DOLERITE
	MVSC	MIDLAND VALLEY SILL-COMPLEX	QUARTZ-DOLERITE
	OVS	OCHIL VOLCANIC FORMATION	BASALTIC ANDESITE
	OVS	OCHIL VOLCANIC FORMATION	PYROXENE-ANDESITE
	OVS	OCHIL VOLCANIC FORMATION	ANDESITIC TUFF
	OVS	OCHIL VOLCANIC FORMATION	CONGLOMERATE
	OVS	OCHIL VOLCANIC FORMATION	RHYODACITE
	OVS	OCHIL VOLCANIC FORMATION	RHYOLITE
	OVS	OCHIL VOLCANIC FORMATION	TRACHYTE GROUP
	OVS	OCHIL VOLCANIC FORMATION	TRACHYANDESITE
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	BASALT AND DOLERITE
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	DIORITE
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	MICRODIORITIC-ROCK
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	MICROGRANODIORITE, PORPHYRITIC
	SDCAD	NORTH BRITAIN SILURO-DEVONIAN CALC-ALKALINE DYKE SUITE	MICRODIORITE, PORPHYRITIC

Figure 3: Bedrock geology

Hydrogeology

Superficial deposits

We have no detailed data on the hydrogeology of the 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. 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 Green Power Ltd and is dated June 2004.

The proposal is for the construction of 14 turbines at Little Law Farm (centred at approximately NN 993 093).

Chapter 9: Hydrology Impact Assessment

Geology

9.2 provides a short geological description. It states that shallow peat is present across most of the site and there are one or two small scattered areas of deeper peat.

Overall, an accurate summary, although mention should be made of the Superficial Deposits (alluvium and till). The peat is not illustrated on the BGS geological map for the area.

Hydrogeology

9.4.4.1 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. Abstraction of groundwater can also be made from water-bearing fractures over 60 m below surface in the weathered or fractured volcanic 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:

9.4.4.1 states that Perth and Kinross Council have identified 79 private water supplies around the proposed wind farm site. Two of these (Shepherd's Cottage and Coulshill Farm) are located within the proposed site area and four (Littlerig, Greenhill, Greenhill Farmhouse and Greenhill Farm Cottage) are located close to the eastern boundary of the site. The other 73 private water supplies identified by the council are considered not to be at risk of being effected by the development.

9.4.3.2 states that Green Power propose to carry out a survey of the remaining six supplies (mentioned in 9.4.4.1) to identify the type and locations of the sources of water supply.

Consultation with local residents identified that Coulshill Farm is supplied by two springs. One (NN 979 093) supplies the farm and another (NN 982 093) supplies the house. Greenhill Farm is supplied by a spring (NO 017 098) and Littlerig obtains its water from a surface water supply. The details of the private water supplies at other properties were not available. A private water supply is recorded at Corb in the ES for the Snowgoat Glen wind farm and this lies within the proposed site area for the Little Law wind farm.

The springs at Coulshill lie within approximately 200 to 300 metres of Turbine 1 and could possibly be affected by the development. The catchment for the supply at Greenhill Farm appears to lie outside the proposed development area and therefore should not be affected by the wind farm.

It is important to determine the location and nature of all private water supplies in the area that could be affected by the development. There are assumptions made in Sections 9.6.2.5 and 9.6.2.6 that surface water is the most likely source of the private water supplies (Paras 3 and 1 respectively) which is a statement that should not be made until the full details of each of the sources is determined. It is likely that many of the properties are supplied from either shallow groundwater in the sand and gravel horizons that occur within the till or from the bedrock where it is locally fractured and weathered.

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.

BGS consider that the Highland Spring operation near Blackford will not be affected by the proposed development.

Surface water:

Section 9.4.4.1 includes a statement which appears to confuse surface water with groundwater. Paragraph 5 refers to spring water as surface water. This should be

clarified by the developer, as spring waters are regarded as being supplied from groundwater.

Sections 9.2 and 9.4 describe, in detail, the hydrology of the area. Section 9.6 describes the impacts on the hydrology of the proposed construction and Figure 19b illustrates the areas that are considered to be hydrologically sensitive and could be affected by construction and maintenance works associated with the proposed scheme. These include areas of wet dwarf heath and where crossing points intercept streams draining the site.

Section 9.4.6 considers that the location of the borrow pit in Corb Glen has the potential to cause adverse impacts on the nearby Water of May and other surface waters.

Sections 9.6.2.5 and 9.6.2.6 consider the impact of the construction work on private potable water supplies and Section 9.8 considers that the impact on the quantity and quality of private domestic water supplies after mitigation is negligible to minor.

Discussions with local residents have indicated that the majority of farms in the area rely on surface water for their livestock. The BGS considers that groundwater baseflow to streams and maintaining the wet dwarf heath areas may be significant. Therefore, the construction of tracks and pits some distance from streams 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

Chapters 6 and 7 comprise impact assessments for vegetation and flora and protected mammals respectively.

BGS consider 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.

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

- The proposed 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 included in 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 springs. There are likely to be several shallow wells and boreholes exploiting these groundwater resources in the area. Shallow groundwater also supports areas of mire and wet heath.
- Whilst the BGS consider 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. The catchments for the spring supplies at Corb and Coulshill Farm are most likely to be affected by the proposed development, but, until further details are available, a more accurate assessment of the risk cannot be made.
- The Highland Spring operation at Blackford will not be affected by the proposed development.
- 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.