1. Reference documents/ Material Considered

Ref 1. Environmental Liability (Scotland) Regulations 2009, Scottish Statutory Instruments 2009 No. 266

Ref 2. The Scotland River Basin District (Status) Directions 2014

Ref 3. 'Paper 11b(i) Groundwater Chemical Classification for the purposes of the Water Framework Directive and the Groundwater Directive', UK Technical Advisory Group on the Water Framework Directive, Feb 2012

Ref 4. Application Under Section 36 for Whitelee Windfarm Extension Phase 3 DPEA Ref: WIN-190-1 Scottish Power Renewables ltd in Respect of Determination B of Pre-examination Meeting Held on 23 Feb 2015

Ref 5 'Whitelee Extension Phase 3, Water Issues –Planning Enquiry (DPEA Ref. Win-190-1), WSP/ Parsons Brinckerhoff on behalf of Scottish Power Renewables, 26th May 2015

Ref 6. 'Legal and Evidential Submission in relation to the Environmental Impact Assessment ' from the Third Party Objectors 'Protect Our Water Group, 5th February 2015

Ref 7. Whitelee Windfarm Extension phases 1 and 2. Private Water Supplies Risk Assessment, Atkins 2010

Ref 8. Environmental Liability (Scotland) Regulations 2009 Draft Guidance, the Scottish Government, August 2009

Ref 9. SEPA Letter response to R. Conner enquiries, SEPA Ref. CM/LT, dated 25th February 2015

Ref 10. Whitelee Windfarm, Groundwater Quality Monitoring Report – July 06 to September 08, December 2008, Jacob Engineering U.K. Limited on behalf of Scottish Power

Ref 11. 'Paper 11b(ii) : Groundwater Quantitative Classification for the purposes of the Water Framework Directive', UK Technical Advisory Group on the Water Framework Directive, Feb 2012

Ref 12. Closing Submission by Third Party Objectors in public examination of application for consent under the Electricity Act, s. 36 for the Third Extension to the Whitelee Windfarm, Dr. Rachel Connor and Mr. Tim Harrison, dated 27th July 2015

Ref 13. 'Preliminary assessment of the hydrogeology of the Whitelee wind farm', Carol, S. on behalf of POW (Protect Our Water) Group, 12th February 2015

Additional References

Ref A: Data extract from unknown report 'Whitelee Windfarm Extension' [SPR W058b] Water Quality Results; Airtnoch Farm, Craigend Farm, Low Overmuir

Ref B: 'Whitelee Extension Phase 3, Water Issues –Planning Enquiry (DPEA Ref. Win-190-1), ECoW Update Note, WSP/ Parsons Brinckerhoff on behalf of Scottish Power Renewables, June 2015

Ref C: Appendix D 'Geochemical Laboratory Testing' extract from unknown Whitelee Windfarm Extension Report, [SPR W059]

Appendix I: 'Drinking Water Protected Areas' in Scotland
Appendix II: Filenote from WRU

2. Summary of Conclusions

The documents listed in Section 1 (hereafter referred to as 'material considered') have been reviewed by Water Resources Unit (WRU) to ascertain whether the activities which have been undertaken, in relation to the construction and operation of Whitelee Windfarm, have caused any damage that significantly adversely affects the status of the groundwater environment.

Three Groundwater Classification 'Tests' are relevant and have been considered. These are; Chemical status-Drinking Water Protected Areas Test, Chemical status-General Quality Assessment Test and Quantitative status -Water Balance Test.

Based on the information available in the material considered, the appropriate groundwater bodies would not fail any of the aforementioned tests. WRU advise that the evidence does not point to there being damage that has significantly adversely affected the Status of the groundwater environment.

3. Background and Scope

WRU has been requested to review various documents relating to the Whitelee Windfarm (the material considered), to advise on whether "Environmental Damage" is likely to have occurred from activities relating to the construction, or operation, of Whitelee Windfarm.

The Whitelee Windfarm Site is located on Eaglesham Moor in the Central Belt of Scotland between East Kilbride and Kilmarnock, NS 570 460. It is the UK's largest onshore windfarm, approximately 55 km^2 and is understood to have over 200 turbines.

- Site History Overview

		2006		2007	2008	2009		2010			2011		2012
		Oct	Dec	Jan	Jan	Jan	July	Jan	Nov	Dec	Jan	Aug	Jan
Whitelee Original	Tree felling &main track construction												
	Turbine base excavations, concreting works and backfilling and restorative works												
Whitelee Extension	Tree felling &main track construction												
	Turbine base excavations, concreting works and backfilling and restorative works												

* Source: contact with Environmental Management and Compliance Manager, Scottish Power Renewables

The scope of this WRU Review is restricted to impacts on the 'chemical' and/or 'quantitative' status of the Groundwater Environment in the context of Environmental Liability (Scotland) Regulations 2009, (hereafter referred to as 'ELR Scotland 2009') and The Scotland River Basin District (Status) Directions 2014 (hereafter referred to as 'Status Directions 2014').

"Environmental Damage" to the Water Environment is defined as damage falling within Regulation 4 of ELR Scotland 2009 as reproduced below;

Ref 1 *- 4. Application*
(1) Subject to regulation 5 [exemptions]*, these Regulations apply in relation to—*
(a) ...
(b) water damage, caused by an activity listed in Schedule 1, which is
(i)any damage that significantly adversely affects any or all of the—
(aa) ecological status;
(bb) chemical status;
(cc) quantitative status;
(dd) ecological potential,
*of the water environment** with the exception of adverse effects where Article 4(7) of Directive 2000/60/EC applies;*

**The groundwater environment, at and around Whitelee Windfarm, is protected under these Regulations as it falls within the 'Drinking Water Protected Areas' Maps.
**The groundwater environment, at and around Whitelee Windfarm, is considered as protected 'waters' by these Regulations as it falls within the 'Drinking Water Protected Areas' Maps.

The Whitelee Forest Area to the West of Strathaven is shown within Map 21 of 22, and the western extent of Whitelee is shown on Map 13 of 22, refer to Appendix I for Maps and Legislative Background on 'Drinking Water Protected Areas' in Scotland.

7. Competent authority

1) For the purposes of these Regulations, the competent authority in relation to instances of environmental damage or an imminent threat of such damage—
(a) to protected species or natural habitats in the territorial sea or coastal water (within themeaning of section 3(8) of the Water Environment and Water Services (Scotland) Act 2003), is the Scottish Ministers;
(b) to protected species or natural habitats in any other place, is Scottish Natural Heritage;
(c) to land or, in relation to environmental damage of the type defined in regulation 4(1)(b)(i), to the water environment, is the Scottish Environment Protection Agency; and
(d) to marine waters, in relation to environmental damage of the type defined in regulation 4(1)(b)(ii), is the Scottish Ministers.

4. Groundwater Body Status

The framework which is used to determine the status of a groundwater body in Scotland is defined in Status Directions 2014 **[Ref 2]**.

In Part B of Schedule 4, of the Status Directions 2014, the criteria and indicators for SEPA to determine whether a 'groundwater body' has good or poor chemical status are set out. Part C sets out the criteria and indicators for determining good or poor quantitative status.

Schedule 5 of the Status Directions 2014, concerns the 'identification of risks to drinking water abstractions'.

Figure 1 shows the groundwater bodies in the Whitelee Area

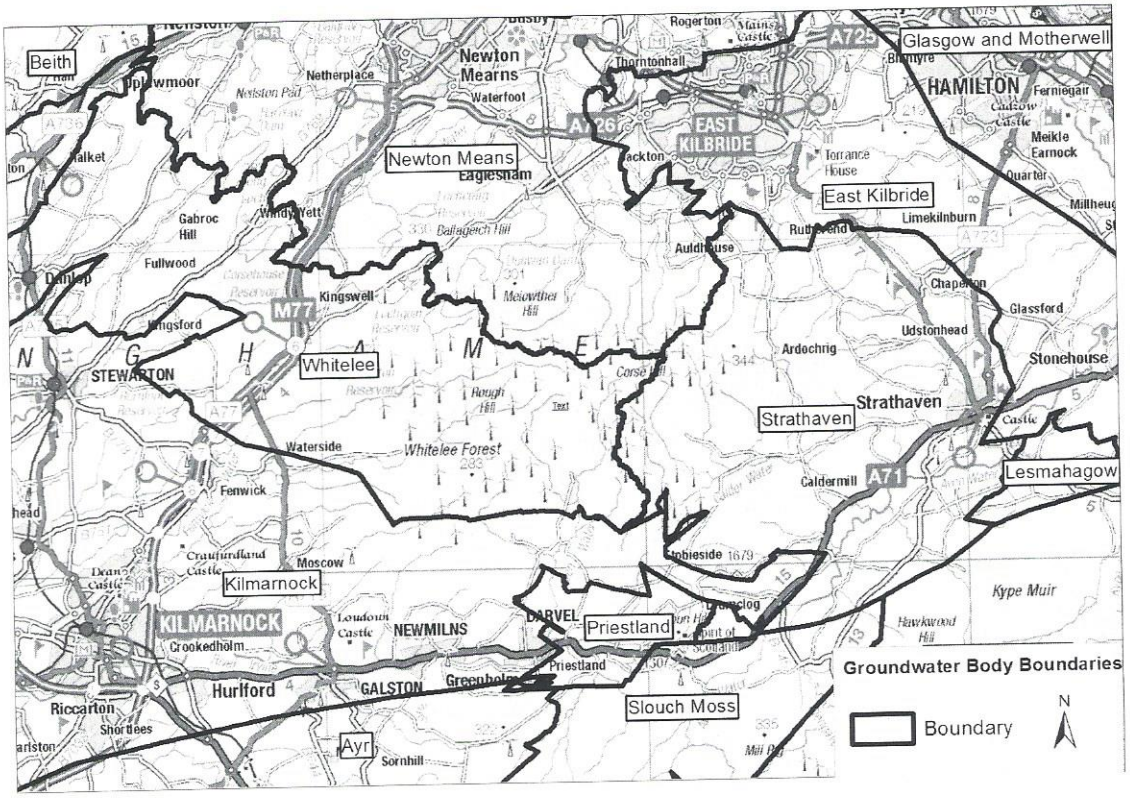

Figure 1: Groundwater Body Boundaries

The tables below provide a summary of the Chemical Status (Table 1) and the Quantitative Status (Table 2) of these groundwater bodies;

Table 1: Groundwater Bodies – Chemical Status

Name	Waterbody ID	Size (km2)	Current Status (2015)
Strathaven (bedrock)	150587	109.5	Good
Whitelee (bedrock)	150599	125.8	Good
Newton Mearns (bedrock)	150622	166.7	Good
Kilmarnock (bedrock)	150662	372.3	Poor

Table 2: Groundwater Bodies - Quantitative Status

Name	Waterbody ID	Size (km2)	Current Status (2015)
Strathaven (bedrock)	150587	109.5	Good
Whitelee (bedrock)	150599	125.8	Good
Newton Mearns (bedrock)	150622	166.7	Good
Kilmarnock (bedrock)	150662	372.3	Good

The groundwater bodies show no change in Status from 2015 back to 2012.

Please note, after 2011 there was a change in the spatial configuration of the groundwater bodies. The equivalent previous groundwater bodies show no change from 2011 back to 2007 except for one groundwater body: the Kilmarnock groundwater body. The Kilmarnock groundwater body was at good status in 2007 and poor thereafter. This is due to an additional assessment test, relating to potential mining impacts on groundwater, being added to the classification process from 2007 onwards.

5. Waterbody Status Tests- Whitelee Windfarm

5.1. Chemical status, Drinking Water Protected Areas Test - Section 7 of 11b(i)

Ref 3, Section 7 - The conditions for good chemical status are not met when: There is a significant and sustained rising trend in one or more key determinands at the point of abstraction and threshold values are exceeded.

- Pertinent Details of this Test

Ref 3 7.2 - *This test is designed to assess groundwater quality trends from the baseline and the relationship of this baseline to drinking water standards. It is not an assessment of whether groundwater is suitable for drinking water purposes. A groundwater body could be at good status but contain water that is only suitable for drinking with purification treatment.*

Ref 3 7.4 *The assessment point for this test is in the raw water at the point of abstraction of "water intended for human consumption" (as defined in the Drinking Water Directive (DWD)). Not all such abstractions need to be assessed. Representative assessment (abstraction) points should be selected, based on the conceptual model of the groundwater body, the pressures and impacts assessment and knowledge of the pattern of abstraction.*

For groundwater assessment, the Drinking Water Protected Areas Test is undertaken by SEPA using monitoring and samples from properly constructed boreholes. The boreholes should not be at risk from surface water ingress or a sub-standard protection, construction & maintenance of the supply infrastructure, as this would allow localised pollution (which can be mitigated against) to inappropriately cause a Status downgrade of the whole groundwater body.

The various water sources (springs, boreholes and uncertain sources) discussed in the 'material considered', are not utilised by SEPA as locations for determining Groundwater Classification. In the context of groundwater status, the nature of these private water supplies, (i.e. that there is a potential for surface water ingress and/or substandard protection), means that the data would not be considered suitable for use towards the Drinking Water Protected Areas Test.

- Examples Moor Farm and Airtnoch

In relation to the Airtnoch tank (likely to supply 9 properties) concern has been raised over elevated levels of bacteria (total coliforms and e.coli) for a period which coincided with Whitelee Windfarm construction (2006 – 2013).

As stated in DPEA Appeal documents submitted on behalf of Scottish Power Renewables (Ref 4 and Ref 5), elevated levels of bacteria appear to be a problem for many private water supplies in the Whitelee Area, and it is concluded that this is likely to be related to animal grazing in the vicinity of the private water supplies. WRU would expect this problem to be particularly exacerbated during periods of heavy rainfall, when the bacteria in the subsurface would be flushed out, and could impact on private water supplies, or in the case of Moor Farm, where the surface water ditch is thought to overflow into the Moor Farm tank supply in periods of higher rainfall.

Other 'material considered' provides the following information/ evidence;

- PWS Outwith the WF Area - Moor Farm Private Water Supply (approx. Easting 250950 Northing 648140) is over 1km from Whitelee Windfarm turbines, this location shows elevated levels of Total Coliforms (ranging from 0 – 32000 MPN) and E.coli (ranging from 0 – 31000 MPN) during Feb 2015 – Apr 2015 weekly sampling.

- Historical problems, page 17 of Ref 6 states that there had been historical problems with bacterial contamination of these water supplies. Page 63 of the May 2015 submission for the DPEA Appeal **[Ref 5]**, reports elevated levels of coliforms detected during 2008, however the turbines in the vicinity of the Airtnoch supply are stated to have been constructed after 2008.

- Water quality data for Airtnoch farm, **[Additional Ref A]** indicates that the 5 highest levels of bacterial contamination coincide with high rainfall events:

Table 3: Overview of rainfall patterns during maximum coliform levels

High Presumptive Coliform (MPN in 100ml)	Date Received	Comments on Rainfall
170000	05/07/2010	23 mm two days earlier
610	06/02/2012	17 mm two days earlier
2500	01/10/2012	31 mm two days earlier
570	01/11/2012	24 mm two days earlier
2200	10/12/2012	27 mm four days earlier

*Note the average rainfall for duration of monitoring period is 4.6 mm/day, the 95th percentile rainfall levels for same period is 20 mm/day.

A survey of private water supplies undertaken in 2010 shows that the Airtnoch tank supply is not sealed, it is covered by a grate which would not prevent surface water ingress into the supply **[Ref 7]**.

Poor water quality data (whether, bacteria, iron or manganese) from sampling these water supplies, would not constitute a failure of the Drinking Water Protected Areas Test as these supplies may not be properly constructed, and at risk from surface water ingress (see section 5.6.).

5.2. **Chemical status, General Quality Assessment Test - Section 8 of 11b (i)**

Ref 3 Section 8 - The conditions for good status are not met when: Threshold values are exceeded at individual monitoring points, and a representative aggregation of the monitoring data at the groundwater body scale indicates that there is a significant environmental risk resulting in a significant widespread impact within a groundwater body or a significant impairment of human uses of the groundwater body.

Note: Groundwater Body scale impact for this Test is considered to be an area in excess of 2km^2, in comparison the monitoring network used to monitor construction of the original Whitelee Windfarm covers an approximate area of 30 km^2 (3000 hectares).

- Pertinent Details of this Test:

Ref 3, 8.1 - The overall aim of the test is to assess if the impact of groundwater pollution is sufficiently widespread to compromise the use of the groundwater resource either currently or in the future. It is not intended to assess local pollution impacts.

Ref 3, 8.4 - Does the exceedance of the threshold value occur across an area sufficiently widespread to compromise the use of the groundwater resource either currently or in the future? ...Sites where individual inputs of pollutants are of sufficient magnitude to pose a risk to local pollution or deterioration in status. These inputs are usually controlled at a site specific level and the location of pollutant inputs is therefore well defined (e.g. a soakaway for treated sewage effluent, a landfill site)..... Therefore the smallest areal size of plume that would constitute a failure of this test is 2 km^2.

Ref 8. page 22, paragraph 69- "As confirmed in European guidance, short-term, transient adverse effects from which the affected water body recovers without the need for remediation measures are not significant enough to cause deterioration of status."

In February 2015 SEPA Operations issued a response **[Ref 9]** to a third party regarding concerns raised in relation to chemical monitoring undertaken in relation to the Whitelee Windfarm. There was concern regarding elevated total petroleum hydrocarbons (TPH), and volatile & semi-volatile organic carbons such as the plasticiser di(2-ethylhexyl) phthalate (DEHP).

Ref 9 - *"The lack of obvious source, in combination with the apparently random detection of DEHP on a very wide scale (boreholes are approx. 2 km apart), gives some support to the statement within the Report that cross contamination within the laboratory maybe the source. Equally the chemical could be detected through sampling practise as the chemical is often found in vacuum pumps which are used for groundwater sampling. The source of the DEHP is considered at this stage to be unclear and may well be as a result of sampling or laboratory cross contamination."*

To provide some detail on this, using DEHP as an example, this contaminant of concern was detected in all groundwater sampling results from 4th September 2006 at concentrations varying between 57 – 67 µg/l, this date is prior to the construction of the original Whitelee Windfarm. Further the contaminant was also detected in the laboratory blank sample results from 4th September 2006 **[Ref 10].**

WRU provided a full review of the Monitoring Report for SEPA Operations to assist in their formal response; this Filenote Review is included in Appendix II. WRU agreed with the recommendations of the Report, that additional monitoring should be undertaken at the Site to resolve the uncertainties regarding water quality at the Site.

Additional concrete specification information included in Appendix B of **Ref B** states that for the Whitelee Windfarm DEHP is not used as a plasticiser. This has been supported by concrete specification sheets and communication with the Cement Product Supplier. WRU would not disagree with the conclusions of this report, submitted on behalf of SPR, "*In respect to the onsite materials inventory, based on*

the information received there remains no evidence to suggest a source for the DEHP as observed in historical groundwater sampling by Jacobs] (within either the concrete nor cabling deployed within any of the different phases of windfarm development)."

Results have been made available from Scottish Power Renewables Ltd commissioned monitoring in the direct vicinity of Whitelee Windfarm, however the dates and monitoring location map are unclear, and no Monitoring Report covering the motivation and interpretation of the results has been provided **[Ref C]**.

The analysis of samples from a series of shallow boreholes (up to 2.10 m depth) has been undertaken in 2010. Water samples were tested for metals, polycyclic aromatic hydrocarbons, phenols, volatile organic compounds and semi-volatile organic **[Ref C]**.

Whilst the motivation for this sampling is unknown, WRU would not raise any concern with the water quality results in this document. Concerns have been made to SEPA Environmental Liability Specialist regarding levels of arsenic in the groundwater, WRU would comment that the results do not appear to show significantly high arsenic levels; of the 12 arsenic results all are below 2 µg/l, apart from one sample from Hole WSSS2, depth 1.42 m, sample ID BS82557 which shows a result of 11 µg/l **[Ref C]**.

The drinking water standard for arsenic is 10 µg/l, after being reduced from 50 µg/l in 2004 on World Health Organisation recommendations.

Samples results from the arsenic data set are generally low, one sample (WSSS2) is slightly above the drinking water standard (ID BS82557), and a sample from the sample hole 3 cm deeper (IDB S82560 result 6.4 µg/l) is below the drinking water standard. Arsenic can be found naturally at low levels in groundwater, and together the WRU findings from the results provided, we would not raise concerns with these results.

It should be noted that the lack of plausible source, elevated concentrations in advance of any Windfarm activities, and erratic nature of the monitoring results indicated that the Windfarm is unlikely to have caused widespread impact.
As such WRU would advise that the general quality of these groundwater bodies would not be downgraded.

Conclusion, applying the General Quality Assessment Test component of 'Chemical Status' the Status of the Groundwater WRU would not deem the Groundwater Environment to be 'significantly adversely' affected in line with Regulation 4 of ELR Scotland 2009 **[Ref 1].**

5.3. Quantitative Status, Water Balance Test - Section 4 of 11 b(ii) [Ref 11]

The water balance test is carried out at a groundwater body scale and compares the annual average abstraction against the available groundwater resource. If abstraction is more than 20% of the available recharge to a groundwater body, combined with evidence that monitored groundwater levels are falling, then the groundwater body is at poor status.

Table 4: Groundwater Quantitative Status

Name	Waterbody ID	Size (km^2)	No. of abstractions	Abstractions as % of recharge	Current Status (2014)
Strathaven (bedrock)	150587	109.5	2	0.09%	Good
Whitelee (bedrock)	150599	125.8	4	0.26%	Good
Newton Mearns (bedrock)	150622	166.7	3	0.08%	Good
Kilmarnock (bedrock)	150662	372.3	2	0.02%	Good

*No change is expected between the Current Status and the 2015 classification results.

The groundwater bodies show no change in Status from 2014 back to 2012.
Please note, after 2011 there was a change in the spatial configuration of the groundwater bodies. The equivalent old groundwater bodies show no change from 2011 back to 2007.

In addition, reduction of groundwater flow as baseflow to surface water and the ecosystems is considered. Reference 4, page 22, paragraph 67- Groundwater quantitative status is principally a measure of the impact of groundwater abstraction on associated surface waters and on terrestrial ecosystems directly dependent on groundwater.

There does not appear to be evidence that there has been a long-term significant reduction of baseflow to these two receptors (surface water and/or terrestrial ecosystems).

The 'material considered' indicates that there have been reductions in the water source available at some Private Water Supplies located to the northwest of Whitelee Windfarm. These are reported as being springfed water sources;

Ref 12, pages 4 and 5
-"losing his water supplies completely for 3 months early in 2007, Mr XXX, at XXXXX, had spontaneous resumption of the original spring water flow, but with noticeable deterioration in quality, with high turbidity and mineral content..."

-"Mr and Mrs XXX reside at XXXXX, less than 1 km from the Easterly margin of the proposed Whitelee Extension 3 site (WL3).
...During 2007, during peak earthworks and construction activity on the WLWF site, in combination with neighbours at XXXXXXXXXX lost their domestic water supplies completely, from what had been a previously reliable spring water source."

It is not within the scope of this WRU Review to comment on whether it is likely that activities related to Whitelee Windfarm either temporarily or permanently affected the spring source available at these private water supplies. However localised impacts could not cause a downgrade in the Status of these groundwater bodies, and the relevant groundwater bodies are found to have sufficient resource at a groundwater body scale.

6. Conclusions

The 'material considered' has been reviewed by Water Resources Unit (WRU) to ascertain whether the activities which have been undertaken, in relation to the construction and operation of Whitelee Windfarm, have caused Environmental Damage to the Groundwater Environment.

In order to review whether Environmental Damage has taken place, the three relevant Groundwater Classification 'Tests' have been considered; Chemical status-Drinking Water Protected Areas Test, Chemical status-General Quality Assessment Test and Quantitative Status -Water Balance Test.

WRU also concur with the statements, made by Hydrogeologists in both the 'Preliminary assessment of the hydrogeology of the Whitelee wind farm' Report **[Ref 13]** and the 'Phase 3- Water Issues Planning Inquiry' Report **[Ref 5]**, that movement of subsurface groundwater in hill peat and glacial till in the Whitelee Area is limited. In general groundwater flow rates within the peat and till deposits are expected to be low, to very low, and as such any potential impacts from the windfarms would be localised, and not of a scale which could impact the quantitative or qualitative status of a groundwater body.