11 Hydrology, Hydrogeology and Geology

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12 Hydrology, Hydrogeology and Geology

12.1 Executive Summary

12.1.1 The hydrology, hydrogeology and geology assessment follows the same methodology outlined and undertaken for the Consented Development. The hydrological study area for the Revised Development has not changed, except the turbine layout has been amended and turbines are now present in the southern area of the site.

12.1.2 The conclusions to the hydrology, hydrogeology and geology assessment below are the same for the Revised Development as those reached for the Consented Development. It is anticipated that there will be no significant residual hydrological, hydrogeological and geological effects as a result of the construction and operation of the Revised Development.

12.2 Introduction

12.2.1 This chapter considers the potential impacts of the Revised Development on hydrology, hydrogeology and geological resources. This includes detailed consideration of potential impacts on surface watercourses, groundwater and the local geology in and around the site and any potential impacts on flood risk in the local area.

12.2.2 For the purposes of this assessment, watercourses have been identified as those which appear on the Ordnance Survey (OS) 1:50,000 scale maps (refer to Figure 11.1). However, on-site observations of field drains and other man-made features have also been made and the presence of these has been taken into account in the design of the scheme and any mitigation measures.

12.2.3 Previous peat probing was carried out on site in 2015. These results have been collated and updated with further survey work on site to determine any further areas of localised peat with the current layout.

12.3 Legislation, Policy and Guidelines

Legislation

12.3.1 Relevant legislation and guidance documents have been reviewed and taken into account as part of this hydrology, hydrogeology and geological assessment. Of particular relevance are:

- The European Union (EU) Water Framework Directive (WFD) has been implemented in Scotland through the Water Environment and Water Services (Scotland) Act 2003 (WEWSA). This Act introduced a regulatory system for the water environment with SEPA as the lead authority working alongside the public, private and voluntary sectors. The Act ensures that all human activities with the potential to cause a harmful effect on the water environment can be controlled by establishing a framework for co-ordinated controls on water abstraction and impoundment, engineering works affecting watercourses, and discharges to the water environment.
- The EC Groundwater Directive provides specific measures to protect groundwater against pollution and deterioration. This Directive is implemented through the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR), introduced under WEWSA to provide the main regulatory controls for protecting the water environment from harm. CAR introduced specific controls for activities affecting watercourses and waterbodies and which encompass the following activities relevant to the Revised Development:
  - discharges to all wetlands, surface waters and groundwater's; and,
  - engineering works in inland waters and wetlands.

12.3.2 SEPA maintains water monitoring and classification systems that provide the data to support the aim of the WFD, namely that all waterbodies are of good ecological status, or similar objective, by 2021. The classification system covers all rivers, lochs, transitional, coastal and groundwater bodies, and is based on an ecological classification system with five quality classes: High, Good, Moderate, Poor and Bad. It has been devised following EU and UK guidance and is underpinned by a range of biological quality elements, supported by measurements of chemistry, hydrology (changes to levels and flows) and morphology (changes to the shape and function of waterbodies).

12.3.3 The Water Resources (Scotland) Act 2013 makes provisions for the development of Scotland's water resources through improved water quality, the creation of contracts for non-domestic sewerage services, protection of the public sewer network and the maintenance of private sewerage works.

12.3.4 The relevant legislation relating to flood prevention is the Flood Risk Management (Scotland) Act 2009, which replaces the Flood Prevention (Scotland) Act 1961 (as amended).

Planning Policy

12.3.5 Chapter 5 sets out the planning policy framework that is relevant to the EIA. The policies set out below include those from the South Lanarkshire Local Development Plan (LDP, 2015). This section also considers the relevant aspects of Scottish Planning Policy (SPP), Planning Advice Notes and other relevant guidance. Of relevance to the hydrological, hydrogeological and geological assessment presented within this chapter, regard has been had to the following policies:

- LDP, Policy 2, Climate Change;
- LDP, Policy 4, Development management and placemaking;
- LDP, Policy 17, Water environment and flooding;
- LDP, Policy 18, Waste;
- PAN 51: Planning, Environmental Protection and Regulation (Scottish Executive, 2006);
- PAN 69: Planning and Building Standards Advice on Flooding;
- PAN 79: Water and Drainage (Scottish Executive, 2006) and
- Scottish Planning Policy (Scottish Government, 2014).

Guidance

12.3.6 Cognisance has been taken of the following best practice guidelines/guidance etc.:

- SEPA Pollution Prevention Guideline (PPG) 1: Understanding your environmental responsibilities - good environmental practices (2013);
- SEPA Guidance for Pollution Prevention (GPP) 5: Works and maintenance in or near water (2017);
- SEPA Policy 19 Groundwater Protection Policy for Scotland (Version 3, 2009) and
- SEPA Policy 41 'A Planning Authority Protocol Development at Risk of Flooding: Advice and Consultation' (SEPA, 2011).

12.4 Consultation

12.4.1 Consultation was undertaken with a number of statutory and non-statutory consultees, in order to obtain information and advice prior to completing the EIA. In order to facilitate initial consultation on the project, consultees were provided with copies of the EIA Scoping Report prepared by previous developers, Community Windpower Ltd, in 2012. Formal scoping responses were received from SNH and SEPA at that time and are summarised below.

12.4.2 In relation to the Revised Development; dialogue and correspondence relevant to the hydrology, hydrogeology and geology assessment was held with SNH and SEPA throughout the 2015 Application, in regard to specific aspects of the project and to discuss various issues following the submission of the original Scoping Report.

12.5 Assessment Methodology and Significance Criteria

Consultation

12.5.1 As noted in Section 11.4, previous consultation has been undertaken with a number of statutory and non-statutory consultees after submission of the 2012 Scoping Report, including SEPA and SNH.

12.5.2 SEPA considers that the key issues that should be addressed in this chapter include the following:

- Carbon balance, where peat and carbon rich soils are present;
- Disruption to wetlands, including peatlands (specific reference is made to groundwater dependent terrestrial ecosystems);
- Details regarding disturbance and re-use of excavated peat;
- Effects on existing groundwater abstractions and provision of details regarding proposed future abstraction;
- Engineering activities proposed within the water environment;
- Provision of details regarding pollution prevention and environmental management and
- Flood risk.

12.5.3 SNH considers that the key issues that should be addressed in this chapter include the following:

- Peat surveys across any areas of peat (SNH states that there is a known presence of peat within the southern section of the site but does not provide the source of this information) and
- Engineering activities proposed within the water environment.

12.5.4 SLC's Environmental Services recommends that consideration is given to the handling, use, short term storage and final reuse of surplus material. Information on known Private Water Supplies within a 1 km study area around the site boundary has also been provided.

12.5.5 The Coal Authority responded in November 2015 agreeing that the recommendations set out in the Mining Risk Assessment (undertaken by Wardell Armstrong) were accurate and that it had no objection to the development, if proposed conditions were undertaken before the project was commenced. The letter of response can be found in Appendix 4.4.

Study Area

12.5.6 The study area has incorporated the area within the site boundary and this assessment also considers any potential hydrological and hydrogeological effects up to 1 km up or downstream of the site.

12.5.7 Information regarding known Private Water Supplies has been obtained from SLC for a 1 km study area around the site boundary.

12.5.8 The criteria for defining the study area have been established based on the professional judgement and experience of the technical authors with regard to likely access and working areas, and with due consideration to the relevant guidance on hydrological and geological assessment.

Desk Study

12.5.9 Baseline conditions have been established primarily through desk-based research which has included:

- consultation with SEPA, SNH and SLC (refer to Appendices 4.1 to 4.4);
- identification of the locations and characteristics of catchments and principal watercourses and waterbodies, as shown on 1:50,000 scale OS mapping which may be affected by construction activities;
- identification of SEPA/WFD watercourse and waterbody classification;
- review of on-line SEPA flood mapping;
- review and collation of pertinent information on surface hydrology, flooding, climate, etc.;
- review of on-line British Geological Survey (BGS) geological mapping of the area;
- review of historical mapping and
- review of drainage/surface water and hydrogeological characteristics and groundwater resource.

Site Visit

12.5.10 An additional site walkover survey to allow for updated information for the Revised Development was undertaken on 03 July 2017. This was to determine whether there have been any changes on site, in particular, relating to hydrological features and presence of peat, due to the change of layout for the Revised Development. There was no evidence of peat on site. Inspection of previously identified water crossings and determination of any other potential water crossings was also assessed while on site. This has been presented in Appendix 11.1.

12.6 Assessment of Potential Effect Significance

12.6.1 The sensitivity characteristics of hydrological, hydrogeological and geological resources have been guided by the matrix presented in Table 11.1, which lists indicative criteria.

Table 12.1 – Sensitivity Criteria (Hydrology, Hydrogeology and Geology)

Sensitivity	Description
High	Areas containing geological, geomorphological or hydrological features considered to be of national interest, for example, Aquatic Natura 2000 sites, Special Areas of Conservation, Sites of Special Scientific Interest. Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Status. Raised or blanket bog. High risk of flooding. Land capable of supporting Arable Agriculture i.e. Class 1, 2 and 3.1.
Medium	Areas containing features of designated regional importance, for example, Regionally Important Geological and Geomorphological Sites (RIGS) considered worthy of protection for their educational, research, historic or aesthetic importance. Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Status. Significant peat deposits.

	Moderate risk of flooding. Land capable of supporting Mixed Agriculture i.e. Class 3.2, 4.1 and 4.2.
Low	Geological features not currently protected and not considered worthy of protection. Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological Status or no WFD classification. Thin superficial peat deposits. Low risk of flooding. Land capable of supporting improved grassland or rough grazing only i.e. Class 5.1 to 7.

12.6.2 The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the aquatic and geological environment including international and national designations, water and soil quality information, waterbody status from the WFD review work undertaken to date by SEPA, consultations, site visits, and the professional judgement of the assessment team.

12.6.3 The prediction and assessment of effects on hydrology, hydrogeology and geology has been undertaken using a series of tables to document the various potential impacts from aspects of the construction and operational phases of the Revised Development. Impacts have been predicted based on the guidance criteria for the magnitude of change set out in Table 11.2. Impacts from aspects of decommissioning are considered to be the same as for construction.

Table 12.2 – Magnitude of Change Criteria (Hydrology, Hydrogeology and Geology)

Magnitude of Change	Guidance Criteria
High	Total loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be fundamentally and irreversibly changed, for example, extensive excavation of peatland or watercourse realignment.
Medium	Loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be particularly changed, for example, in-stream permanent bridge supports or partial excavation of peatland.
Low	Small changes to the baseline resource, which are detectable but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions e.g. culverting of very small watercourses/drains.
Negligible	A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no change' situation, for example short term compaction from machinery movements.

12.6.4 Using these criteria, potential effects resulting from the Revised Development have been assessed. These effects are presented in Section 11.8. Details of generic and site specific mitigation measures are given in Section 11.9, with the remaining residual effects detailed in Section 11.10.

12.6.5 The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource. A matrix of significance, based on the combination of magnitude of change and sensitivity of receptor, was developed to provide a consistent framework for evaluation. This is shown in Table 11.3 below.

Table 12.3 – Significance of Effect Matrix (Hydrology, Hydrogeology and Geology)

Sensitivity of Receptor	Magnitude of Change			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

12.6.6 The guideline criteria for the various categories of effect are provided in Table 11.4.

Table 11.4 – Guideline Criteria for Significance of Effect (Hydrology, Hydrogeology and Geology)

Significance	Definition	Guidance Criteria
Major	A fundamental change to the environment.	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance, or changes resulting in substantial loss of conservation value to geological or aquatic habitats and designations.
Moderate	A large, but non-fundamental change to the environment.	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability, or changes resulting in loss of conservation values to geological or aquatic habitats or designated areas.
Minor	A small but detectable change to the environment.	Localised changes resulting in minor and/or reversible effects on soils, surface and groundwater quality or habitats.
Negligible	No detectable change to the environment.	No effects on geological resources, drainage patterns, surface and groundwater quality or aquatic habitats.

12.6.7 In the above classification, fundamental changes are those which are permanent, either adverse or beneficial, and would result in widespread change to the baseline environment. For the purposes of this assessment, those effects identified as being major or moderate have been evaluated as significant environmental effects in terms of the EIA Regulations and, therefore, are those which may have an adverse effect on the status of waterbodies, watercourses, groundwater or geological resources.

12.6.8 These matrices have been used to guide the assessment, though they have been applied with a degree of flexibility, since the evaluation of effects will always be subject to location-specific characteristics which must be taken into account. For this reason, the evaluation of the significance of effects in particular will not always correlate exactly with the cells in the relevant matrix, especially where professional judgement and knowledge of local conditions may result in a slightly different interpretation of the impact concerned.

12.6.9 Cumulative effects have been accounted for through the prediction and evaluation of effects at a catchment-wide level.

Requirements for Mitigation

12.6.10 Proposed mitigation measures are presented within this chapter where the potential to affect sensitive geological, hydrological or hydrogeological receptors has been predicted. These may include temporary effects from construction or permanent/longer-term effects associated with the operational phase of the Revised Development and its associated infrastructure.

Assessment of Residual Effect Significance

12.6.11 An assessment of any predicted significant residual effects on sensitive geological, hydrological or hydrogeological receptors is presented within this chapter.

Limitations to Assessment

12.6.12 No water quality monitoring or intrusive investigations have been undertaken. Peat probing data from the previous 2015 Application has been used in this assessment.

12.7 Baseline Conditions

Geology (including soils)

12.7.1 Bedrock geology, as shown on Figure 11.2, is indicated to comprise six main strata which generally fault in a north-westerly to south-easterly direction. The far eastern site area is underlain by Passage Formation sedimentary rock cycles of the Clackmannan Group type.

12.7.2 The part of the site containing turbines T06 and T07, is underlain by rocks of the Upper Limestone Formation, comprising Clackmannan Group type sedimentary rock cycles. Intrusive limestone dykes have also formed within this Formation.

12.7.3 Part of the northern site area, which has previously been disturbed by opencast coal operations and has no turbines proposed is noted to comprise the Limestone Coal Formation and Lower Limestone Formation, with intrusive limestone dykes.

12.7.4 A band of sedimentary rock cycles associated with the Lawmuir Formation Strathclyde Group type underlies the central part of the site, encompassing turbines T04, T05, T08 and T09. An intrusive limestone dyke has also formed within this Formation.

12.7.5 The central and western site area comprises mainly Kinneswood Formation, encompassing turbines T02 and T03. Turbine T01 on the very western edge of the site, lies on a section of Upper Limestone Formation.

12.7.6 Finally, the movement of turbines into the southern area of the site, encompassing turbines T10, T11, T12 and T13 is indicated to comprise the Swanshaw Sandstone Formation.

12.7.7 In respect of the solid geology, it is recognised that much of the central and northern parts of the site have been significantly altered by previous opencast coal operations which were undertaken on the site during the late 1980s and early 1990s. A 3-D model of the previous excavations has been obtained and has been used to inform the layout of the Revised Development to ensure that no turbines have been positioned on deep areas of opencast backfill. Figure 3.1 shows the extent of the excavation undertaken and the overall area which was disturbed by mining. It is therefore noted that whilst Figures 11.2, 11.3 and 11.4 show the original geological baseline position at the site, they do not take account of the alterations and impact that the opencast operation has had on both the soil resource and the solid geology within the site.

12.7.8 A Mining Risk Assessment was carried out by Wardell Armstrong in 2015, to assess the Revised Development site and surrounding area. Risks identified were the presence of recorded and potentially unrecorded shallow mine workings and the potential presence of unrecorded mine entries. Following ground investigations to fully identify any risk, the proposed layout was revised

to avoid any area of backfilled excavation that occurred for the former coal site. The full report can be found in Appendix 11.3.

12.7.9 Overall, the sensitivity of the baseline geological resources at this site are considered to be low.

12.7.10 BGS online mapping for the area shows that the superficial geology underlying the site comprises predominantly till, which in this particular area would normally be expected to comprise stiff to hard clay with inclusions of sand, gravel and boulders (Figure 11.3).

12.7.11 It is noted in the SNH scoping response (May 2012) that peat is present in the southern area of the site. This is not indicated on any geological mapping provided by the BGS. In response to this, a targeted peat probing survey was undertaken on 02 April 2015, comprising 94 probes in a 100 m grid pattern, around the ES 2015 turbine layout (turbines 8, 14 and 15). An additional 57 probes were also taken at all of the turbine centres and at approximately 50 m intervals along the proposed new access tracks. Surveys were carried out in line with Guidance on Developments on Peatland - Site Surveys (2014) and the Good Practice during Wind Farm Construction Guidance (September 2015), to identify any peat deposits that may be present around those turbines and associated infrastructure. With submission of the updated ES, a site visit was carried out on the 03 July 2017, where no peat was identified on site. The locations and findings of the peat probe results in 2015 are illustrated on Figure 11.5.

12.7.12 The Joint Nature Conservation Committee (JNCC), Report No. 445, Towards an assessment of the state of UK Peatlands, (2011) presents the definition of peat, deep peat and organo-mineral (peaty) soils. This definition, which has been used within this chapter, is summarised below:

- Peaty (or organo-mineral) soil: a soil with a surface organic layer less than 0.5 m deep;
- Peat: a soil with a surface organic layer greater than 0.5 m deep which has an organic matter content of more than 60 %;
- Deep peat: a peat soil with a surface organic layer greater than 1.0 m deep.

12.7.13 As illustrated on Figure 11.5, the Probe Depth Survey from 2015 identified no peat deposits in the parts of the site which were to be disturbed by the Consented Development. In general, probes reached no further than 0.5 m in depth before reaching till. On Figure 11.5, three probes along the stretch of new track between T1 and T4 show a probe depth of between 51 cm and 75 cm. At each of these locations, the probe depths were less than 57 cm through peaty clay soils and not considered to be deep peat. One probe extended to just over 1 m and another to just under 1.5 m in depth before reaching till in the south of the site, however these were through soft peaty clay soils within flush zones, rather than through peat deposits. A further site walkover survey undertaken on the 03 July 2017 relating to the Revised Development, recorded only one area of peaty soil deposits in the southern area of the site, within a flush zone adjacent to Longhill Burn. Ground conditions around turbines T10, T11, T12 and T13 were noted to comprise thin peaty soils in places, overlying stiff glacial till again determining that there were no peat deposits on site.

12.7.14 In the absence of any peat deposits being present, no further assessment of peat resources, specifically Peat Slide Risk Assessment, Peat Management Plan or associated carbon balance calculations have been undertaken.

12.7.15 In respect of the soil resource across the site, it is noted that in the central/northern part of the site, some of the areas previously disturbed by opencast operations have previously been backfilled and have very little to no original soil cover and are dominated by soft rush. The site is generally covered in non-calcareous gleys and peaty gleys, as shown on Figure 11.4.

12.7.16 Much of the central and northern site area has previously been disturbed by opencast mining activities and the area between Turbines T04 and T06 was subject to significant excavation and backfilling (refer to Figure 3.1).

Hydrogeology

12.7.17 The groundwater body beneath the site is indicated by SEPA RBMP Map (2011), to comprise the Lanark bedrock and localised sand and gravel moderately productive aquifer. This groundwater body was classified by SEPA in 2008 as having an overall status of poor with high confidence in 2008. The key pressures on the groundwater body are associated with former mining and quarrying of coal.

12.7.18 There has been significant ground disturbance of the central and northern areas of the site associated with former surface mining of coal and backfilling with worked materials. There is evidence that the drainage patterns within the northern area of the site, around turbines T04, T05, T06, T07 and T08 have been disrupted based on the significant coverage of soft-rush across this part of the site. Groundwater flows will have also likely been significantly disrupted by the previous surface mining operations.

12.7.19 Chapter 7, paragraphs 7.7.6 to 7.7.10 (including Table 7.12) of this ES provides evidence of some potential moderate and high groundwater dependent terrestrial ecosystems present within the southern area of the site. Turbines T10, T11 and T12 lie within an area of potentially moderate GWDTEs.

12.7.20 Historical borehole records for the site obtained from the British Geological Survey indicate that this undisturbed part of the site is covered by a significant layer of glacial till comprising dense gravelly clay for depths of between 3.5 and 5 m. The underlying bedrock is indicated as being sedimentary in nature and therefore has the capacity for moderate groundwater flows. However, whilst the bedrock may act as a moderate source of groundwater, the dense glacial till deposits do not form an effective pathway for groundwater movement. Therefore, it is clear that those plant communities identified within the site boundary with the potential to have dependence on groundwater are, in reality, likely to be predominantly dependent on surface and/or rain water, and are therefore not Groundwater Dependent Terrestrial Ecosystems. SEPA has previously agreed with this conclusion in its response to South Lanarkshire Council, dated 28 August 2015, in connection with the Consented Development.

12.7.21 SLC was consulted regarding the presence of Private Water Supplies (PWS) within the site boundary. Information provided by SLC on the 28 April 2015 and correspondence on the 28 July 2017 confirmed that there are no PWS's within 1 km of the site boundary and no evidence of PWS's was observed during the site walkover. An assessment of effects on private water supplies is therefore not considered further within this chapter.

12.7.22 Overall, the sensitivity of baseline hydrogeological resources beneath this site are considered to be low.

Hydrology

12.7.23 As shown on Figure 11.1, the Poniel Water, which is a tributary of the Douglas Water, flows from west to east along the north-western boundary of the site. It forms part of the overall catchment of the River Clyde. In 2008 SEPA classified the Poniel Water as having an overall status of moderate with high confidence. SEPA has set an overall objective of increasing this status to good by 2027. Similarly to the underlying groundwater body, the key pressures on the watercourse are associated with former mining and quarrying of coal. In this regard, it is noted that the original course of this stretch of the Poniel Water used to run further south prior to it being diverted to facilitate the Dalquhandy Opencast operations in the early 1990s.

12.7.24 The photograph below from September 1990 shows the original course of the Poniel Water through the site and the diversion channel being excavated.

12.7.25 Shiel Burn, Longhill Burn and Alder Burn are tributaries of the Poniel Water and flow from south to north through the western, central and eastern parts of the site respectively. These watercourses do not have a SEPA classification regarding status. However, as tributaries of the Poniel Water, they are anticipated to have a similar overall status.

12.7.26 There are four main ponds on the site at the following locations:

- To the north east of Turbine 9 (T09), fed by the Alder Burn;
- Between T08 and T09, fed by a small, unnamed watercourse which then feeds into the Alder Burn;
- To the east of T05 and south west of T06, which is fed by the Longhill Burn. This pond was created as part of the restoration of the previous opencast operation; and
- Between T03 and T04, which is fed by an unnamed watercourse within the plantation woodland.

12.7.27 During the site visit on 03 July 2017, it was noted that another area of ponding had formed immediately to the north of T03. The cause of this ponding was observed to be a blocked pipe culvert beneath the existing site haul road.

12.7.28 All watercourses mentioned above form part of the catchment area of the River Clyde which is a salmonid water. Previous electrofishing surveys were undertaken in July 2012 in all watercourses associated with this site. The results of these surveys indicated that fisheries habitat quality and fish utilisation potential ranged from poor/very low (not assessed/sampled) to low/high (assessed/sampled) across the various watercourses. At each sampling site, the composition of fish fauna was generally dominated by cyprinid species, with some brown trout also present.

12.7.29 New watercourse crossings, represented in Figure 11.1, will be required where the proposed access tracks cross a watercourse. As such, a water crossing schedule is presented in Appendix 11.1.

12.7.30 For the purposes of this assessment, the sensitivity of baseline hydrological resources at this site are considered to be high.

Flooding

12.7.31 The online SEPA flood risk map indicates that most of the site has no risk of flooding. A desk based Level 1 Flood Risk Assessment (FRA) has been undertaken to assess the local potential effects of the Revised Development on fluvial and pluvial flooding at the site and this is presented in Appendix 11.2. The conclusion of the FRA is that risk of fluvial and pluvial flooding as a direct result of the Revised Development is low. The banks of the Poniel Water and a small pond located to the east of T05 and south west of T06, which is fed by the Longhill Burn, are indicated to be at risk of localised flood events, however, as described in Section 3.3 of this ES, site drainage will be designed to avoid point discharge of large flows directly to the Poniel Water. A detailed drainage design will be undertaken and submitted to SEPA and the Local Authority for approval prior to construction. Therefore, the baseline sensitivity of this site to flooding is considered to be low.

Contaminated Land

12.7.32 The site has been subject to extensive surface mining in the past but all areas previously worked on this part of the former Dalquhandy Opencast site have been backfilled with materials from the site. There is therefore considered to be only limited potential for contaminative material to be present in underlying soils.

12.7.33 For the purposes of this assessment, the sensitivity of receiving watercourses to exposure to contaminative materials, and therefore their overall sensitivity is considered to be high.

12.8 Potential Effects

12.8.1 The potential effects resulting from the Revised Development are detailed below. Effects have been separated into those which occur during the construction, operation and decommissioning phases individually.

Construction

12.8.2 The construction phase includes all activities prior to the operation of Revised Development, i.e. up to the point at which the turbines begin generating electricity. The following paragraphs outline the potential effects identified, with respect to geology, hydrology and hydrogeology during this phase.

12.8.3 All potential effects have been determined as having a high sensitivity during construction, prior to the implementation of mitigation measures.

Pollution/Sedimentation of Watercourses during Construction

12.8.4 There is a potential for surface runoff containing silt and other sediments, particularly during and after rainfall events to enter the watercourses and field drains on-site. Silt and sediment laden surface water runoff is predicted to arise from excavations, exposed ground and any temporary stockpiles. This has the potential to temporarily impact on the water quality and hydrological and ecological function of the receiving watercourse at and downstream of the works.

12.8.5 The sensitivity of the Poniel Water and its associated tributaries, has been assessed as high. All proposed hardstanding associated with the Revised Development, is outwith the 50 m watercourse buffer. The four pond areas identified onsite lie adjacent to the existing access road. The potential for construction-related, sediment-laden runoff to directly enter either of these water bodies is therefore limited due to their distance from proposed new construction works.

12.8.6 The magnitude of change, prior to mitigation, is medium. Therefore, there is likely to be a direct, temporary, short-term effect of **major** adverse significance prior to the implementation of mitigation measures on watercourses.

Pollution Impact from chemical contaminated runoff

12.8.7 Pollutants such as oils and fuel may be mobilised through mechanical leaks or spillage and carried in surface drainage. Unless managed appropriately, the pollutants could be washed into watercourses, impacting on freshwater quality and ecological value.

12.8.8 A temporary concrete batching area on site has the potential to allow for spillages into surface waters before draining into and polluting surrounding watercourses. This could impact on freshwater quality and ecological value unless managed appropriately.

12.8.9 As above, the sensitivity of the Poniel Water and its tributaries as well as any ponds present on site have been assessed as high. Overall there is likely to be a direct, temporary, medium-term effect of **major** adverse significance on watercourses prior to the implementation of mitigation measures.

Impact from soil compaction

12.8.10 Soil compaction occurs as a result of construction of permanent roads and by movement of construction vehicles and plant. Soil compaction can cause a reduction in water permeating to the ground, resulting in an increase in potentially contaminated surface runoff. Reduced permeability in soils also reduces the site's flood storage capacity which may result in localised flooding incidents. Superficial groundwater flows can also be impacted through compaction of soils which obstruct the lateral movement of the groundwater through the soils.

12.8.11 The magnitude of change, prior to mitigation, is low. Therefore, there is likely to be a direct, temporary, medium-term effect of **moderate** adverse significance on watercourses prior to the implementation of mitigation measures.

Impact on the integrity of banking

12.8.12 Construction activities on or close to the sides of watercourses can detrimentally affect the structural integrity of the burn banks, either through direct damage to bankside material or indirect loosening of soil structure thus impacting on the localised morphology and water quality of the watercourse through erosion or even collapse of the banking.

12.8.13 Permanent watercourse crossings will be required across both natural and artificial watercourses to allow access for construction and maintenance vehicles.

12.8.14 These include replacement of circular culverts at WC01 and WC02 (the latter with a new bridge), and new circular culverts at WC03 and WC05. A circular and three pipe culvert already exist at WC04 and WC06 respectively. These are described in Chapter 3 and summarised in Table 11.5 below:

Table 11.5: Water crossing detail

Reference	Existing / New	Type	New Track required for Access
WC01	New /Replace existing	Circular culvert	T01 & T02
WC02	New/ Replace existing	Bridge structure	T01 & T02
WC03	New	Circular culvert	T01, T02 & T03
WC04	Existing	Existing circular culvert	
WC05	New	Small circular culvert	T09, T10, T11, T12 & T13
WC06	Existing	Existing three pipe culvert	

12.8.15 All new and existing culverts were identified during the site visit on the 03 July 2017. Further assessment including descriptions, photographs and crossing details can be found in Appendix 11.1.

12.8.16 The magnitude of change, prior to mitigation, is medium. Therefore, there is potential for a direct, permanent, medium-term effect of **major** adverse significance prior to the implementation of mitigation measures.

Direct discharge of untreated foul drainage

12.8.17 Unless appropriately sited and managed, there is potential for direct discharge of untreated foul sewage from welfare facilities from site compounds during construction.

12.8.18 The magnitude of change, prior to mitigation, is medium. Therefore, there is likely to be a direct, temporary, medium-term effect of **major** adverse significance on watercourses prior to the implementation of mitigation measures.

Operation

12.8.19 The operational phase includes all activities during the operation of Revised Development, i.e. during the time in which the turbines are generating electricity. The following paragraphs outline the potential effects identified, with respect to geology, hydrology and hydrogeology during this phase.

12.8.20 All potential effects have been determined as having a high sensitivity during operation, prior to the implementation of mitigation measures.

Surface water drainage

12.8.21 The permanent access track and crane hardstandings for the wind turbines could result in additional surface water flows, potentially resulting in soil erosion and silt-laden runoff, which could pollute watercourses, ditches and ponds.

12.8.22 The magnitude of change, prior to mitigation, is high. Therefore, there is potential for a direct, permanent, short-term effect of **major** adverse significance prior to the implementation of mitigation measures.

Fluvial Geomorphology

12.8.23 If standard box or pipe culverts for watercourse crossings are not designed properly to ensure continuous flows, this could potentially adversely reduce the geomorphological diversity of the stream.

12.8.24 The magnitude of change, prior to mitigation, is medium. Therefore, there is potential for a direct, permanent, short-term effect of **major** adverse significance prior to the implementation of mitigation measures.

Direct discharge of untreated foul drainage

12.8.25 Unless appropriately sited and managed, there is potential for direct discharge of untreated foul sewage from the substation and control room during operations.

12.8.26 The magnitude of change, prior to mitigation, is medium. Therefore, there is likely to be a direct, temporary, medium-term effect of **major** adverse significance prior to the implementation of mitigation measures.

Decommissioning

12.8.27 Potential effects of decommissioning of the Revised Development are similar to those encountered in the construction phase, however, generally with less magnitude as the level of site activity is lower.

12.8.28 Discussions will be held with SLC and the appropriate Regulatory Authorities prior to decommissioning to agree an appropriate Decommissioning Strategy.

12.9 Mitigation

Project Design

12.9.1 The assessment of baseline conditions at the site has identified that the surface watercourses at the site are the key sensitive receptors. A summary of the hydrological influences on the project layout are given below with full details of the project design provided in Chapter 3. Due to the nature of the environment occupied by the Revised Development, it is imperative that the design of the infrastructure helps to maintain or, if possible, improve the local hydrology. Poor design of wind farm infrastructure can result in significant implications to the hydrological environment with secondary effects on aspects such as ecology.

12.9.2 The Revised Development layout is more considerate towards the hydrological regime of the area compared to the Consented Development. Turbine infrastructure and hardstandings are placed at a greater distance from watercourses and waterbodies, and there are fewer proposed new water crossings. This helps reduce the overall hydrological impact on the area.

12.9.3 A 50 m buffer was implemented for all watercourses considered to have continuous flow throughout the year in designing the project. These buffers are shown on Figure 11.1.

Pre-construction site investigations

12.9.4 In order to determine the ground and groundwater conditions across the site, pre-construction site investigations will be conducted. These investigations will focus on areas where construction is proposed to be undertaken and will allow the turbines and the associated infrastructure to be micro-sited away from unsuitable areas, such as areas of contamination or where there are significant groundwater flows.

12.9.5 The investigations will also include targeted monitoring and assessment of the groundwater levels and flows beneath the site. This will allow for micro-siting of the features of the Revised Development and to assist in the detailed design of infrastructure and selection of appropriate materials for use during the construction process.

Construction

Water Quality

12.9.6 The appointed Contractor will undertake pre-construction baseline water quality sampling and analysis at the Poniel Water, Shiel Burn, Longhill Burn and Alder Burn and implement a programme of regular monitoring and analysis of the water quality of the watercourses throughout the construction period.

Pollution Impact from Silt-laden Runoff

12.9.7 With specific reference to the SEPA '*Guidelines for Water Pollution Prevention from Civil Engineering Contracts*' and '*Special Requirements*', the Contractor will produce a Construction Environmental Management Plan (CEMP) prior to the commencement of construction activities which contains a construction method statement that includes:

- a detailed breakdown of the phasing of construction activities;
- a pollution risk assessment of the site and the proposed activities;
- identification of all Controlled Waters that may be affected by the works and temporary discharge points to these watercourses;
- planning and design of appropriate pollution control measures during earthworks and construction management of the pollution control system, including dewatering of excavations away from watercourses;

- contingency planning and emergency procedures; and
- on-going monitoring of construction procedures to ensure management of risk is maintained.

12.9.8 All earthmoving works or similar operations will be carried out in accordance with BSI Code of Practice for Earth Works BS6031:1981.

12.9.9 All concrete batching activities will be undertaken a minimum of 30 metres from any watercourse or surface drain to minimise the risk of runoff entering a watercourse. The concrete batching area will have a contained facility for washing out and cleaning of concrete batching plant.

12.9.10 All watercourse crossings and site discharges will be regulated under the CAR licensing regime and all necessary licences will be sought from SEPA prior to the commencement of any operations on site.

12.9.11 While it is acknowledged that best practice to minimise run-off would be to undertake construction and dismantling during the driest period of the year, given the location of the Revised Development site in South Lanarkshire, there are likely to be significant periods of rainfall throughout the year. Therefore, site management will check the local weather forecast daily and prime all site staff to ensure that everyone is aware of their responsibilities to maintain the pollution control system during wet weather or suspend sensitive operations during adverse weather conditions.

12.9.12 Where topography dictates that working platforms are needed, these will be formed to ensure that surface water drains away from watercourses.

Pollution Impact from Chemical Contaminated Runoff

12.9.13 All fuel and other chemicals will be stored in accordance with best practice procedures, including being kept within a designated fuelling site located at a safe distance from existing watercourses and in appropriate impermeable bunded containers/areas, which will be defined within the CEMP. These will be designed to capture any leakage, whether from a tank or from associated equipment such as filling and off-take points, sighting gauges etc., all of which will be located within the bund.

12.9.14 Oil booms and soakage pads will be maintained in all work areas and spill kits kept in all vehicles to enable a rapid and effective response to any accidental spillage or discharge. All construction staff will be trained in the effective use of this equipment.

12.9.15 Construction vehicles and plant will be regularly maintained and all maintenance, fuelling and vehicle washing will be undertaken on appropriate impermeable surfaces away from watercourses in order to minimise risks of leaks to soil and surface waters.

12.9.16 The temporary concrete batching area on site will have a micro-siting allowance of 50m in all directions. The Contractor will develop a method statement to address the batching, transport, transfer, handling and pouring of liquid concrete at foundations in order to minimise risks of spillage to soil and surface waters.

12.9.17 Cement, grout and unset concrete will not be allowed to enter the water environment. No operations involving concrete transfer between vehicles or into vehicles will take place within 30 m of watercourses and water bodies.

12.9.18 All vehicles used for delivery of concrete will only be washed out at locations to be agreed with SEPA. Excess concrete or wash-out liquid will not be discharged to drains or watercourses on site or at compounds. Drainage from washout facilities will be collected and treated or removed to an appropriate treatment point/licensed disposal site.

12.9.19 The requirement for dewatering will be minimised in all locations by timely and efficient excavation of the foundation void and subsequent concrete pouring and backfilling.

Impact from soil compaction

12.9.20 The proposed new access tracks have been designed to use the shortest amount of track possible, while respecting topographical and other environmental constraints. In the main, topsoil and subsoil will be stripped over the full width of the road corridor, including the drainage channel. Strip depths will vary, but will normally be around 500 mm down to a substrate of firm till or weathered rock. Stripped soils will be stored in temporary windrows on either side of the road, and then used in forming soft verges to roads, or to improve soil cover on the previously opencast areas within the site.

12.9.21 The CEMP will also include a requirement for defined and delineated working areas for heavy machinery to avoid unnecessary compaction of soils.

Impact on integrity of banking

12.9.22 During the construction phase, construction staff will be instructed to maintain a sufficient distance from the burns located on site in order to ensure there is no incursion towards the burn.

12.9.23 Where the required water crossings are being constructed, foundations will be set back to prevent impact on the integrity of the banking of watercourses. Detailed design will be included within a Construction Method Statement to be agreed with SLC and SEPA and detailed watercourse crossing designs will be regulated under the CAR licensing regime.

Direct discharge of untreated foul drainage

12.9.24 Welfare facilities will either connect directly to the foul sewer, self-contained storage tanks or to a septic tank, subject to approval from Scottish Water and SEPA.

12.9.25 If self-contained or septic tanks are to be used, these will be maintained and emptied on a regular basis by a suitably licensed contractor.

Operation

Surface Water drainage

12.9.26 The proposed track and hardstanding design principles for the Revised Development are presented in Chapter 3.

12.9.27 Prior to construction, a detailed Drainage Strategy (DS) will be developed and agreed with SEPA and SLC. The DS will detail the site drainage design, the type of surface to be used for the access track, the soft engineering and habitat enhancement measures proposed to slow surface water flows and any necessary ponds, swales, cross drains and bunds, to ensure that runoff from hard surfaces will be controlled. The DS will also detail the dimensions of any proposed pipe culverts for watercourse crossings which will be designed to maintain continuous flows.

Fluvial Geomorphology

12.9.28 The detailed design for the watercourse crossings, and the requirements for CAR authorisations or licences, will be agreed with SEPA prior to construction in order to ensure that impacts are minimised.

12.10 Residual Effects

12.10.1 When the committed mitigation measures detailed in Section 11.9 are implemented with the appropriate management and monitoring required, then no significant adverse residual effects (minor to negligible adverse effects) from the Revised Development are predicted on hydrological, hydrogeological and geological resources.

12.11 Cumulative Assessment

12.11.1 This assessment has concluded that there will be no significant effects on geological resources associated with the Revised Development. As such, no significant cumulative effects on geological

resources associated with the Revised Development, in combination with other similar local developments currently operational, consented or in planning, are predicted.

12.11.2 In terms of hydrology and hydrogeology, the operational Hagshaw Hill Wind Farm & Extension, Nutberry Wind Farm, Galawhistle Wind Farm and Hazelside Farm and the consented Cumberhead, Dalquhandy and Poniel Wind Farms, lie partially within the catchment area of the Poniel Water.

12.11.3 A proportion of the drainage from these wind farms are likely to drain into the Poniel Water, although flows are also likely to be distributed to other watercourses as well. All of these wind farms either have, or will be required to prepare their own drainage strategies to protect all receiving watercourses from pollution and increased runoff. Therefore, with no predicted residual effects on the Poniel Water from the Revised Development, it is considered that the combined effect on hydrology will be **negligible** and no additional mitigation measures over and above those committed to in this chapter are considered necessary to address cumulative effects on hydrology or hydrogeology.

12.12 Summary

12.12.1 The Poniel Water, which is a tributary of the Douglas Water, flows from west to east along the north western boundary of the site. It forms part of the overall catchment of the River Clyde. The Shiel Burn, Longhill Burn and Alder Burn are tributaries of the Poniel Water. These flow from south to north through the western, central and eastern parts of the site respectively. The burns which are present are considered within the assessment to have good water quality.

12.12.2 The rock beneath the site is typically carboniferous in nature, which is covered by stiff clay then subsoils and topsoils. The central and northern site areas have historically been subject to significant disturbance and backfilling as a result of surface coal mining operations.

12.12.3 Potential construction and operational effects include the risk of pollution of watercourses resulting in adverse effects on water quality and loss of soil integrity resulting in changes to drainage patterns and effects on the integrity of watercourse banks.

12.12.4 The mitigation measures set out in this chapter will be drawn together into a Construction Environmental Management Plan prior to the commencement of construction activities. These mitigation measures are considered to be robust and implementable and will reduce the magnitude of potential impacts on watercourses to minor. Therefore, the significance of residual effects on geology, surface water and groundwater, following the implementation of these mitigation measures, is considered to be **minor** or **negligible** and therefore **not significant**.

Table 12.4 – Summary Table

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect		Comparison with the Consented Development
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse	
During Construction / Decommissioning						
Pollution/Sedimentation of Watercourses	Major	Adverse	• 50 m buffer around watercourses. • Water quality monitoring. • Pre-construction site investigations. • CEMP and construction site management and pollution management plans.	Minor	Adverse	No Change
Pollution Impact from Chemical Contaminated Runoff	Major	Adverse	• 50 m buffer around watercourses for new infrastructure, where practicable. • Water quality monitoring. • CEMP and construction site management. • Micro-siting of concrete batching area, with no batching activities, concrete transfer between vehicles or into vehicles taking place within 30 m of watercourses and water bodies.	Minor	Adverse	No Change
Impact from soil compaction	Moderate	Adverse	• Detailed ground investigations and micro siting away from sensitive areas. • Stripped soils will be stored in temporary windrows on either side of the road, and then used in forming soft verges to roads, or to improve soil cover on the previously opencast areas within the site. • The CEMP will include a requirement for defined and delineated working areas for heavy machinery to avoid unnecessary compaction of soils.	Negligible	Adverse	No Change

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect		Comparison with the Consented Development
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse	
Impact on the integrity of banking	Major	Adverse	• CEMP (including water-crossing design) and construction site management plan.	Negligible	Adverse	No Change
Direct discharge of untreated foul drainage	Major	Adverse	• 50m buffer around watercourses. • Water quality monitoring. • CEMP and construction site management. • Welfare facilities will be approved by Scottish Water and SEPA.	Minor	Adverse	No Change
During Operation						
Surface water drainage	Major	Adverse	• Site design, including drainage design. • 50 m buffer around watercourses.	Minor	Negligible	No Change
Fluvial Geomorphology	Major	Adverse	• Site design, including drainage design and CAR authorisations will be agreed with SEPA prior to construction in order to ensure that impacts are minimised.	Negligible	Adverse	No Change
Direct discharge of untreated foul drainage	Major	Adverse	• Installation of septic tank in line with manufacturer's recommendations. • Regular cleaning and maintenance.	Negligible	Adverse	No Change
Pollution Impact from Chemical Contaminated Runoff	Major	Adverse	• Appropriately impermeable bunded fuelling and chemical storage areas. • All staff trained in emergency clean up procedures. • Regular maintenance of vehicles and equipment to minimise risk of leaks to soil and surface waters.	Negligible	Adverse	No Change
Cumulative Effects						

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect		Comparison with the Consented Development
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse	
Drainage from cumulative wind farms into the Poniel Water and other tributaries	Major	Adverse	• All of these wind farms either have, or will be required to prepare their own drainage strategies to protect all receiving watercourses from pollution and increased runoff.	Negligible	Adverse	No Change

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