

# Chapter 9: Geology and Carbon Balance

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## 9. Geology and Carbon Balance

### 9.1. Executive Summary

- 9.1.1. An assessment has been undertaken of the potential effects on geology and peat during the construction, operation and decommissioning phases of the Proposed Varied Development. As part of this assessment a revised Carbon Balance Assessment has been undertaken.
- 9.1.2. The bedrock beneath the Site comprises Altnaharra Psammite Formation, with Leucogranite igneous plutons and Lewisianoid Gneiss Complex outcrops in the south-east. Superficial deposits where present, comprise peat, Glacial Till and Alluvium. The peatland identified is predominantly Class 2 with areas of Class 1, according to NatureScot's Carbon and Peatlands Map, 2016.
- 9.1.3. Several detailed peat depth surveys have been undertaken across the Site in support of the Consented Development, and these have been augmented with additional data gathered in 2025 in support of the Proposed Varied Development.
- 9.1.4. Peat has been avoided where possible by the Consented Development. Peat surveys confirmed the average peat depth across the Site to be 0.6m. A site-specific Peat Landslide and Hazard Risk Assessment (PLHRA) undertaken at the Site for the Consented Development has confirmed that there is negligible to low likelihood of a peat landslide at the proposed turbine locations and associated infrastructure for the Proposed Varied Development.
- 9.1.5. Updated excavation and reuse volumes have been calculated for the Proposed Varied Development, all excavated peat would be re-used and relocated in accordance with the Consented Development EIAR Outline Peat Management Plan (**2021 EIAR Technical Appendix 11.3**).
- 9.1.6. Most of the peatland onsite has been confirmed as modified peat, with localised areas of near natural, actively eroding and drained peatland. The Proposed Varied Development avoids areas classified as near natural peatland, taking other onsite constraints into consideration.
- 9.1.7. There are no designated areas of protection located within the Site, including Geological Conservation Review (GCR) sites. According to the Zetica website, the Site is within a low bomb risk area.
- 9.1.8. The net emissions of carbon dioxide from the Proposed Varied Development are expected to be 129,919 tonnes of CO<sub>2</sub>e, with a payback time of 3.3 years.
- 9.1.9. The proposed amendments to the Consented Development do not change the findings of **Chapter 11: Geology and Carbon Balance** of the **2021 EIAR** and the good practice

measures detailed in the 2021 EIAR remain wholly applicable and relevant to the Proposed Varied Development.

- 9.1.10. The significance of likely effects therefore remains as assessed in the 2021 EIAR and 2022 AIR and no significant effects would arise as a result of the Proposed Varied Development.

## 9.2. Introduction

- 9.2.1. SSE Renewables Ltd (hereafter ‘the Applicant’) is proposing to vary Achany Extension Wind Farm (hereafter ‘the Consented Development’) to increase the hub height of all 18 turbines to a new maximum tip height of up to 200m (hereafter ‘the Proposed Varied Development’). A description of the Proposed Varied Development is provided in **Chapter 2: Design Iteration and Proposed Development**.

- 9.2.2. This chapter considers the updated potential effects of the Proposed Varied Development on geology, peat and provides an updated carbon balance assessment.

## 9.3. Scope of Assessment

- 9.3.1. The scope of this assessment has been informed by the previous assessment on Geology and Carbon Balance in **Chapter 11** of the **2021 EIAR** and **Chapter 7** of the **2022 AIR** for the Consented Development and consultation responses from statutory consultees in response to the Scoping Report for the Proposed Varied Development.

## 9.4. Consultations

- 9.4.1. **Table 9.1** provides details of consultation undertaken with regulatory bodies, together with action undertaken by the Applicant in response to the Scoping Opinion of the Proposed Varied Development.

**Table 9.1 Consultation Responses**

Consultee and Date	Consultation Response	Applicant Response
SEPA 24 June 2025	As this proposal overlays much of an existing consent, a certain level of survey information has already been collected. However, we can see from the peat survey submitted with the Scoping Report, that the proposed infrastructure is larger and not exactly in the same location. Therefore, we would expect further detailed peat survey data to be conducted to inform the location of the proposed infrastructure. We would expect peat depths of over 1m to be avoided, in line with the NPF4 Policy 5 mitigation hierarchy. Since the last consent there have been numerous	Additional higher density peat depth probing was undertaken where proposed infrastructure has moved from the Consented Development.  The results of the additional peat survey are presented in Section 9.6 of this chapter, and in <b>Figure 9.1</b> .  Section 9.5 of this report notes relevant planning policies and guidance that has been published since the Consented

Consultee and Date	Consultation Response	Applicant Response
	<p>updates to guidance and policy. Please review or Scoping requirements below for what may have changed since the last consent. We would encourage the applicant to send us their peat surveys in draft form at as early a stage as possible to discuss placement of infrastructure in relation to avoidance of peat and peatland condition mapping to avoid near natural habitats.</p> <p>Where proposals are on peatland or other carbon rich soils, the following should be submitted to address our requirements in relation to NPF4 Policy 5 to protect Carbon Rich Soils and the ecosystem services they provide (including water and carbon storage). It should be clearly demonstrated that the assessment has informed careful project design and ensured, in accordance with relevant guidance and the mitigation hierarchy in NPF4, that adverse impacts are first avoided and then minimised through best practice.</p> <ul style="list-style-type: none"> <li>- Peat depth survey showing peat probe locations, colour coded using distinct colours for each depth category. This must include adequate peat probing information to inform the site layout in accordance with the mitigation hierarchy in NPF4,</li> <li>- Peat depth survey showing interpolated peat depths.</li> <li>- Peatland condition mapping – the Peatland Condition Assessment photographic guide lists the criteria for each condition category and illustrates how to identify each condition category.</li> </ul>	<p>Development and have been used to undertake the assessment for the Proposed Varied Development.</p> <p>A peat depth plan showing 2025 peat depth data overlain with the Proposed Varied Development is shown in <b>Figure 9.1. Figures 9.2a-f</b> illustrate all combined peat depth data gathered to date and overlain with the Consented vs Proposed Varied Development.</p> <p>A peatland condition assessment was undertaken as part of the Consented Development, this is detailed in, <b>EIAR 2021 Volume 4 – Technical Appendix 8.10: Outline Habitats Management Plan (oHMP)</b> with Figure 8.10.1, detailing peat condition features, onsite. The Proposed Varied Development avoids areas classed as near natural condition (Section 9.6).</p>
<p>Scottish Ministers 13 August 2025</p>	<p>Scottish Ministers consider that where there is a demonstrable requirement for peat landslide hazard and risk assessment (PLHRA), the assessment should be undertaken as part of the EIA process to provide Ministers with a clear understanding of whether the risks are acceptable and capable of being controlled by mitigation measures. The Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation, should be followed in the preparation of the EIA report, which should contain such an assessment and details of mitigation measures. Where a PLHRA is not required clear justification for not carrying out such a risk assessment is required. Due to the</p>	<p>Further detailed peat depth surveying was undertaken to survey areas of the Proposed Varied Development not surveyed by existing peat depth data from the 2021 EIAR (refer to <b>Figure 9.1</b>)</p> <p>A PLHRA was prepared as part of the Consented Development <b>2021 EIAR Volume 4 – Technical Appendix 11.2</b>. This concluded a Negligible to Low risk of peat instability across the Site.</p>

Consultee and Date	Consultation Response	Applicant Response
	<p>increase in turbine height and the slight change in location, Scottish</p> <p>Ministers recommend that further peat survey data is collected to determine the location of the proposed infrastructure.</p>	<p>As the change in location of the Proposed Varied Development infrastructure is minor compared to the Consented Development the risk of peat instability is considered to be unchanged from the initial assessment, Section 9.6 of this Chapter provides further detail.</p>
	<p>Where borrow pits are proposed as a source of on-site aggregate they should be considered as part of the EIA process and included in the EIA report detailing information regarding their location, size and nature. Ultimately, it would be necessary to provide details of the proposed depth of the excavation compared to the actual topography and water table, proposed drainage and settlement traps, turf and overburden removal and storage for reinstatement, and details of the proposed restoration profile. The impact of such facilities (including dust, blasting and impact on water) should be appraised as part of the overall impact of the working. Information should cover the requirements set out in 'PAN 50: Controlling the Environmental Effects of Surface Mineral Workings'.</p>	<p>A Borrow Pit Appraisal (<b>2021 EIAR Volume 4 – Technical Appendix 11.1</b>) was undertaken as part of the of the Consented Development EIAR. This includes an overview of aggregate requirements and quality for all potential borrow pits, including an overview of borrow pit design and suitable environmental management during excavation and restoration of borrow pits. The consented borrow pits can provide all the aggregate required for the Proposed Varied Development and the approved borrow pits do not need to be revised - additional details are addressed in Section 9.9.</p>
The Highland Council 25 July 2025	<p>The assessment of the impact on peat must include peat probing for all areas where development is proposed. This should include probing not just at the point of infrastructure as proposed by the scheme but also covering the areas of ground which would be subject to micro-siting limits. THC expects all peat impact compensation and enhancement measures to be fully compliant with the current policy and guidance</p>	<p>Further detailed peat depth surveying was undertaken to survey areas of the Proposed Varied Development not covered by existing peat depth data from the 2021 EIAR. The results of the additional peat survey are presented in Section 9.6 of this chapter, and in <b>Figure 9.1</b>.</p>
	<p>Carbon balance calculations should be undertaken and included within the EIAR with a summary of the results provided focussing on the carbon payback period for the wind farm.</p>	<p>Section 9.7 of this chapter details the results of the revised Carbon Balance Assessment.</p>
	<p>The EIAR should fully describe the likely significant effects of the development on the local geology including aspects such as borrow pits, earthworks, site restoration and the soil generally including direct effects and any indirect. Proposals should demonstrate construction practices that help to minimise the</p>	<p>Section 9.6 of this chapter details the assessment of effects for the Proposed Development on geological receptors.</p> <p>The number, location and size of borrow pits is unchanged from the Consented Development.</p>

Consultee and Date	Consultation Response	Applicant Response
	use of raw materials and maximise the use of secondary aggregates and recycled or renewable materials. Where borrow pits are proposed the EIAR should include information regarding the location, size and nature of these borrow pits including information on the depth of the borrow pit floor and the borrow pit final reinstated profile.	2021 EIAR Technical Appendix 11.1: Borrow Pit Assessment of the Consented Development EIAR provides an overview of borrow pit design and committed environmental management during excavation and restoration of borrow pits. This remained unchanged for the 2022 AIR and is also considered to be applicable to the Proposed Varied Development and therefore no further assessment has been undertaken.

## 9.5. Assessment Methodology

- 9.5.1. The methodology used for the assessment of the Proposed Varied Development uses the same methodology as presented within **Chapter 11: Geology and Carbon Balance** of the **2021 EIAR**.

### Legislation, Guidance and Policy

- 9.5.2. The planning policies and guidance outlined in the Consented Development remain relevant with the exception of the planning policies and guidance listed below which have been published since the Consented Development 2021 EIAR was submitted and therefore have been used in the assessment for the Proposed Varied Development.

#### Planning Policy

- NPF4: Policy 5 Soils;
- NPF4: Policy 22 Flood Risk and Water Management; and
- NPF4: Policy 33 Minerals.

#### Guidance

- Advising on Peatland, Carbon-Rich Soils and Priority Peatland Habitats in Development Management (NatureScot, 2023); and
- Good Practice During Wind Farm Construction (NatureScot, 2024).

#### Carbon Calculator

- 9.5.3. The previous online SEPA Carbon Calculator Tool (Reference UIRC-LUK8-7CN3v5) utilised for the Consented Development is currently unavailable. The spreadsheet version of the Scottish Government Windfarm Carbon Assessment Tool v2.14.1 has been used to carry out an updated assessment of the carbon impact of the Proposed

Varied Development. It should be noted that the spreadsheet tool is an older version of the online tool and is not directly comparable with the online tool.

### **Study Area**

- 9.5.4. The study area for assessment of geological receptors comprises the area within the Red Line Boundary.

### **Desk Based Assessment**

- 9.5.5. The following data sources have been reviewed to confirm the baseline conditions at Site to ensure a contemporary assessment is completed:
- British Geological Survey (BGS) mapping sheet 102E “Lairg”;
  - BGS Geoindex digital map viewer;
  - Scottish Environment Protection Agency Website (SEPA);
  - Scotland’s Historic Land Use Map;
  - Zetica UXO un-exploded bomb website;
  - The Mining Remediation Authority Map Viewer
  - National Library of Scotland Map; and
  - Scotland’s Soils map viewer.

### **Field Survey**

- 9.5.6. To support updated assessment for the Proposed Varied Development and address scoping responses, additional peat depth probing was undertaken in August 2025 by SLR surveyors to obtain more detailed coverage on peat extents at the Proposed Varied Development infrastructure locations and where previous peat survey data in support of the Consented Development EIAR did not provide sufficient coverage in accordance with current guidance. The additional peat depth survey was carried out using the following pattern:
- Typically, on an approximate 10m × 10m survey grid for peat depth at the Proposed Varied Development infrastructure locations where no previous data was present; and;
  - Probe points every 50 m along the proposed access tracks, with offset peat depth survey points either side of the access track centre line, and at turning heads.

## **9.6. Consented Development EIAR Baseline**

- 9.6.1. This section summarises the geology and peat baseline setting for the Consented Development which is also applicable for the Proposed Varied Development (see **Chapter 11** of the **2021 EIAR**).



- 9.6.2. Where relevant, data presented in **Chapter 11** of the **2021 EIAR** has been checked against current published data sources and baseline conditions verified. A site visit was also undertaken by SLR geologists in August 2025 to confirm ground conditions where new infrastructure is proposed.

### **Bedrock Geology**

- 9.6.3. BGS Onshore 1:50,000 scale mapping indicates that the bedrock underlying the majority of the Site comprises Altnaharra Psammite Formation, a Psammitic rock formed by low grade metamorphism. Leucogranite igneous plutons and Lewisianoid Gneiss Complex are shown to outcrop in the south-east of the Site along the access track and therefore may be encountered beneath the Psammite. Volume 3 - Figure 11.2 of the 2021 EIAR, shows the Bedrock Geology underlying the Site.

### **Structural Deposits**

- 9.6.4. BGS 1:50,000 scale mapping indicates there to be minor faulting running parallel to the Glen Cassley River, within the river valleys eastern side slopes. A significant fault has been recorded along the bed of Allt Bad an t-Sagairt, a minor tributary to the Glen Cassley River, situated to the north of the Site. No fault line directly underlies the Site, however faults within the region are identified as thrust faults with barbs on hanging wall side. The faults also commonly share an easterly downthrow direction.

### **Superficial Geology**

- 9.6.5. BGS 1:50,000 scale mapping indicates that peat superficial deposits underlie most of the Site and access. Glacial Till is present, with Alluvium deposits comprising of clay, silt, sand and gravel, associated with onsite watercourses. Where superficial deposits are not mapped, bedrock geology is anticipated close to the surface. Volume 3 - Figure 11.1 of the 2021 EIAR, shows the Superficial Geology underlying the Site.

### **Peat**

- 9.6.6. Three phases of peat probing were carried out as part of the Consented Development EIAR, this confirmed the average depth of peat onsite was 0.6m.
- 9.6.7. As part of the Consented Development EIAR (see **2021 EIAR Volume 4, Technical Appendix 11.2**), a Peat Landslide Hazard and Risk Assessment (PLHRA) was undertaken to determine the baseline peat stability conditions. The outcome of this concluded the risk of peat instability occurring to be Negligible to Low across the Site.
- 9.6.8. As part of the Consented Development EIAR an Outline Peat Management Plan (PMP) was prepared. The PMP stated a total excavation volume during construction of 244,307m<sup>3</sup> with a re-use volume of 244,463m<sup>3</sup>, demonstrating a -157m<sup>3</sup> deficit and that all excavated peat can be re-used within the Consented Development. This shows a good balance between extraction and re-use of peat within the Consented Development.



## Peatland Condition

- 9.6.9. A peatland condition class survey was undertaken to confirm peat conditions across the Site as part of the Consented Development EIAR. The results of the survey show most of the Site to be classified as modified peat condition, actively eroding and drained peatland, with localised areas of near natural (**2021 EIAR Volume 4 - Technical Appendix 8.10: Outline Habitat Management Plan (oHMP), Figure 8.10.1**). The Consented Development avoids areas classified as near natural peatland, taking other onsite constraints into consideration. Details of peat condition within the Site were provided in the **2021 EIAR Volume 4 – Technical Appendix 8.10, oHMP**.

## Designated Sites

- 9.6.10. There are no designated areas of protection located within the Site, including Geological Conservation Review (GCR) sites.

## Unexploded Ordnance (UXO)

- 9.6.11. The Zetica website was reviewed for potential Unexploded Ordnance (UXO) and indicated that the Site is within a low bomb risk area.

## 9.7. Carbon Calculator

- 9.7.1. Net emissions calculations for the 18 turbine AIR and Proposed Varied Development have been undertaken using the current version of the ECU Carbon Calculator to allow a direct comparison of the consented and proposed varied applications (refer to **Technical Appendix 9.1: Carbon Calculator**).
- 9.7.2. The net emissions of carbon dioxide from the Proposed Varied Development are expected to be 129,919 tonnes of CO<sub>2</sub>e, with a payback time of 3.3 years. This has been compared against a similar calculation for the Consented Development, using the same carbon calculator for direct comparison purposes, the emissions were estimated at 149,708 tonnes of CO<sub>2</sub>e with a payback time of 4.1 years. This can be further compared with the output from the alternative SEPA Carbon Calculator Tool v1.6.01 used in the **2022 AIR (Chapter 7 and Appendix B)**, which calculated emissions of 152,759 tonnes of CO<sub>2</sub>e and a payback time of 3.2 years for the Consented Development.
- 9.7.3. The differences in emissions calculations and payback time is attributed to the use of different calculator tools and calculation methods embedded therein. The comparison has shown however that the changes associated with the Proposed Varied Development result in a decrease in net emissions and payback time.

## 9.8. Summary of Effects Predicted & Mitigation Measures suggested for the Consented Development

- 9.8.1. The Consented Development assessed the impact on geological receptors, including peat, superficial deposits and solid geology. The impacts to receptors during the construction, operation and decommissioning phases of the Consented Development were predicted to range from negligible to minor and therefore, considered to be not significant, with the implementation of embedded mitigation, relevant guidance and best practice measures.
- 9.8.2. Additional mitigation measures beyond embedded mitigation, guidance and best practice measures were not required for the Consented Development as potential effects were not significant. Therefore, the significance of residual effects on geology, and peat receptors following the implementation of relevant guidance and best practice measures were considered to be negligible and therefore not significant.

## 9.9. Revised Assessment of Effects for the Proposed Varied Development

### Updated Baseline

- 9.9.1. The baseline conditions for Proposed Varied Development bedrock geology, structural deposits, superficial geology, designated sites and UXO are unchanged from the Consented Development assessment.
- 9.9.2. The borrow pit search areas identified for the Consented Development remain valid for the Proposed Varied Development. The previous assessments (**Technical Appendix 11.1 and Chapter 7 of the 2022 AIR**) concluded that the removal of two turbines and associated track reduced aggregate requirement by approximately 3,400m<sup>3</sup>, with sufficient aggregate availability confirmed, subject to ground investigation, there will likely be a surplus capacity of aggregate across the five borrow pit locations. Given that the changes associated with the Proposed Varied Development are minor, it is considered that the existing consented borrow pit search areas can provide sufficient stone for the Proposed Varied Development. No change to the borrow pit search areas or extents is required. Additional peat depth survey was undertaken in August 2025 to achieve comprehensive coverage across the Proposed Varied Development infrastructure, this concluded the average peat depth across the Site to be 0.6m, the same average depth as the Consented Development, the updated peat depth plan is shown in **Figure 9.1** and **Figure 9.2**.
- 9.9.3. Although additional probing was undertaken, this does not alter the conclusions of the original PLHRA. the design changes from the Consented Development to the Proposed Varied Development are minimal. Consequently, the risk to peat stability at and within the area of the Proposed Varied Development is recorded as negligible to low.

9.9.4. The results of the additional peat depth surveying were used to update the excavated peat volumes for the Proposed Varied Development. It is calculated that a total excavated volume of 251,671m<sup>3</sup> with a re-use volume of 252,874m<sup>3</sup>, demonstrating a -1,203m<sup>3</sup> deficit. All excavated peat can therefore be re-used within the Proposed Varied Development.

9.9.5. **Table 9.2** summarises the estimate of material volumes to be excavated and re-used during the construction of the Proposed Varied Development.

**Table 9.2 Summary of Peat Excavation and Re-use Volumes**

Infrastructure	Volume of Peat Excavated (m <sup>3</sup> )	Volume of Peat Reused and Reinstated (m <sup>3</sup> )
Access Tracks (including floated tracks)	60211	38185
Turning Heads	3256	800
Permanent Turbine and Hardstanding	26299	1995
Temporary Hardstanding	35189	35189
Borrow Pits	107282	156445
All other infrastructure (Temporary Construction Compound, Substation, Welfare Unit, Batching Plant, Operations Building)	19434	20260
<b>Total</b>	<b>251671</b>	<b>252874</b>

9.9.6. The Proposed Varied Development avoids areas classified as near natural peatland, in line with the approach taken for the Consented Development.

### Construction

9.9.7. There has been no change to baseline conditions from the Consented Development. The assessment of effects for the Proposed Varied Development is the same as the Consented Development for all receptors during construction. As there has been additional probing undertaken to fully assess potential effects to peat this is reassessed below and uses the results of additional peat depth probing for the extent of the Proposed Varied Development.

9.9.8. Approximately 251,671m<sup>3</sup> of peat and peaty soils will be excavated as part of the Proposed Varied Development. All peat can be beneficially reused on-site and in accordance with the principles detailed within the Peat Management Plan **Technical Appendix 11.3 of the 2021 EIAR**, with no surplus materials (waste).

- 9.9.9. The layout of the Proposed Varied Development minimises excavation of peat as far as practicable. Therefore, it is considered that the potential impact on peat and carbon rich soils is similar to the Consented Development EIAR and not significant.

### **Operation**

- 9.9.10. The impacts to geological receptors during operation is considered to be unchanged from the Consented Development. Therefore, the impact of the Proposed Varied Development is considered to be not significant.

### **Decommissioning**

- 9.9.11. The potential effects during the decommissioning phase of the Proposed Development are expected to be similar to during the construction phase. Due to reduced Site activity, impacts are predicted to be of the same or lesser magnitude, with resultant effects being the same or lesser significance to construction phase effects, and therefore not significant.

## **9.10. Revised Mitigation Measures for the Proposed Varied Development**

- 9.10.1. The embedded mitigation outlined in **2021 EIAR Chapter 11: Geology and Carbon Balance** and **2021 EIAR Technical Appendix 3.1: Outline Construction Environmental Management Plan (CEMP)** remains applicable. No revised or updated mitigation measures are required for the Proposed Varied Development.

## **9.11. Comparison of Effects of the Proposed Varied Development with the Effects of the Consented Development**

- 9.11.1. The Consented Development considered impacts to peat, superficial deposits and solid geology. The significance of effects of the Consented Development were assessed as negligible and not significant.
- 9.11.2. The impact to geological receptors and peat during the construction, operation and decommissioning phase have also been considered for the Proposed Varied Development. The significance of effects has been assessed as negligible and not significant.

## **9.12. Conclusion**

- 9.12.1. This chapter confirms that the assessment within the Consented Development EIAR remains unchanged for the Proposed Varied Development.
- 9.12.2. The impacts to geological receptors during the construction, operation and decommissioning phase of the Proposed Varied Development has been assessed as

negligible and therefore, not significant, with the implementation of mitigation, through guidance and best practice measures as outlined in the 2021 EIAR prepared in support of the Consented Development.

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